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BARNES (H. F.). **Gall Midges of economic Importance. Vol. V. Gall Midges of Trees.**—8½×5½ ins., 270 pp., 8 pls., 445 refs. London, Crosby Lockwood & Son, Ltd., 1951. Price 15*s*.

This fifth volume of a series on Cecidomyiids of economic importance [*cf. R.A.E.*, A **37** 400, etc.] deals with those that attack forest and ornamental trees and resembles the others in scope and arrangement [*cf.* **34** 251].

ALKAN (B.). **Orta Anadolu hububat zararlıları (zararlı hayvan ve böcekler).** [The Cereal Pests of Central Anatolia (harmful Animals and Insects).]—*Yayın. Ankara Üniv. Ziraat Fak.* no. 1, viii+132 pp., 8 maps, 49 figs., 52 refs. Ankara, 1948. (With a Summary in German.)

This survey of the animal pests of cereal crops in central Anatolia is based on the literature and researches by the author in 1939–41 and deals very largely with insects. These are arranged systematically and notes are given on their morphology, food-plants, bionomics, local distribution and in some cases natural enemies, importance and control. The distribution of some of them is shown on maps. Among the Orthoptera, *Dociostaurus maroccanus* (Thnb.) and *Calliptamus* spp., chiefly *C. italicus* (L.), are the most injurious, while *Locusta migratoria* (L.) and *Schistocerca gregaria* (Forsk.) cause damage in the south in some years. The most harmful Lepidoptera are *Sitotroga cerealella* (Ol.), which infests wheat, barley and maize in the field and persists on the stored grain, and *Pyrausta nubilalis* (Hb.) and *Heliothis armigera* (Hb.) (*obsoleta* (F.)) on maize. *Anisoplia* spp. injure wheat by feeding on the milk-ripe grains, and with *Zabrus* spp., are the most injurious of the beetles. Numerous species of thrips occur, but, like the Diptera and Hymenoptera, are of little economic significance.

By far the most important pests of all are the Pentatomids, *Eurygaster integriceps* Put. and *Aelia rostrata* Boh., and special attention was devoted to them. These bugs are commonest in the southern parts of the country, where they overwinter in masses in the mountains beneath such plants as *Astragalus* and *Acantholimon*, fallen leaves and other shelter. They have been found up to nearly 7,500 ft. Both species fly to fields of grain between March and mid-May, somewhat earlier in the more southerly regions than in the more northerly, and return to the mountains at harvest or a little after. Wheat, barley and rye are the main crops attacked, and there is only one generation a year. The grains are attacked in the stage of milky ripeness, and the baking qualities of the flour are much impaired. Infestation is greater in some years and places than in others, and this is apparently due to climatic differences. Four developmental regions in Anatolia are distinguished for *Eurygaster* by the author and shown on a map. The bugs have few natural enemies other than birds, but *Microphanurus* (*Telenomus*) *semistriatus* (Nees) parasitises many of the eggs of *Eurygaster* in favourable years [*cf. R.A.E.*, A **20** 489]. Control was directed chiefly against the bugs in their hibernation quarters, and very great numbers were destroyed by burning *Astragalus* and *Acantholimon* plants beneath which they were sheltering. Numerous other Pentatomids also occur in the fields, but are of less importance than these two.

BUSVINE (J. [R.]). **Insects and Hygiene. The Biology and Control of Insect Pests of medical and domestic Importance in Britain.**—8½×5½ ins., xiv+482 pp., frontis., 57 figs., many refs. London, Methuen & Co., Ltd., 1951. Price 30*s*.

The first seven chapters of this comprehensive monograph on arthropods of medical and domestic importance in Britain are general in character. In addition to the introductory one in which notes are given on ways in which

arthropods affect health, arthropods as destructive household pests and historical aspects, they comprise accounts of the structure and classification of insects (and the classification of the Arachnida), anatomy and physiology, ecology of individual insects and insect populations, the organisation of measures for the prevention and control of infestation, mechanical and physical control measures and insecticides. The chapter on insecticides is divided into a section on theory and one on practice. Their mode of action and factors affecting it are dealt with in the former, and typical stomach poisons, contact poisons, fumigants and repellents, the ways in which they are used and risks of toxicity and damage in the latter.

The next nine chapters deal with the bionomics, importance and control of special groups of insects. Most of these are of medical or sanitary importance, but three chapters are concerned with insects and mites that are pests of foodstuffs, clothes moths and carpet beetles, and wood-boring beetles.

There are also two appendices. The first includes keys for the identification of the pests, and the second consists of directions for the estimation of insecticides and an alphabetical list of insecticidal substances with notes on their composition and properties.

COATON (W. G. H.). *Trinervitermes* **Species—the Snouted Harvester Termites.** —*Bull. Dep. Agric. S. Afr.* no. 261, [1+]19 pp., 10 figs., 4 refs. Pretoria, 1948.

Methods of eradicating species of the subgenus *Trinervitermes* of *Eutermes*, the feeding and nesting habits of which are described, were investigated in South Africa in 1946–47. These termites are numerous in the Union, especially on veldt under grass or grass and Karroo-bush [*Pentzia incana*] in the central parts of it ; they appear to reach peak abundance in an area including adjoining parts of the Orange Free State, Transvaal and Cape Province, which is characterised by low and irregular rainfall and periodic summer drought. The termites collect and store grass, especially the finer species, and under normal conditions, when their mounds are widely separated, they cause little damage ; when infestation is severe, however, the stock-carrying capacity of the veldt is seriously lowered, soil erosion is facilitated, and some plants are eliminated from the grass complex. If the grass cover is reduced by heavy grazing, dry climatic conditions or winter burning (which is of no value against the population in the mounds), the termites range further afield in search of grass and construct temporary, supplementary mounds near the food-supply. This increase in mound density does not represent an increase in population, but the presence of deserted and derelict mounds facilitates the initiation of new colonies, since they provide suitable elevated sites on which the winged reproductives can alight and also, when softened by weathering, an easy means of ingress into the soil, thus shortening the period during which the reproductives are exposed to predators. About 25 per cent. of 260 derelict mounds in a heavily infested area had become reinfested.

When infestation is severe, resting the veldt for a few years is insufficient in itself to promote recovery, since reseeding is hindered by the termites and the increased food-supply provided by the extension of the area of grass favours the growth of the population. It is therefore necessary to reduce the infestation and destroy the mounds before applying such measures of veldt reclamation as reseeding, the elimination of bush encroachment, and controlled grazing.

Eradication methods were studied in a heavily infested area in the Orange Free State that had been overstocked and was in consequence overgrown with *Gnidia polycephala*, which also helped to prevent recovery ; heavy stands of this shrub were always associated with large termite populations. There was

an average of 100 mounds per morgen [a little over two acres], of which 70 were inhabited ; surveys showed that the population present would destroy nearly 20 per cent. of the grass cover during a normal, dry winter, and that the damage would increase to 60 per cent. after a second one if there had been drought during the intervening summer. The basal circumference of the mounds was less than 6 ft. in 57·4 per cent. of cases, 6–10 ft. in 22 per cent., and 10–28 ft. in 20·6 per cent. ; all the inhabited mounds that exceeded 6 ft. in circumference and some of the smaller ones were breeding mounds. Of various measures tested in 1946, the only satisfactory ones were fumigation with medium solvent naphtha at 2–10 fl. oz. per mound, which was cheap and gave excellent mortality, but left the mound intact and liable to reinfestation ; complete excavation and fragmentation by labourers, which was slow but gave 95 per cent. control if it was carried out when winged reproductives or nymphs that would shortly give rise to them were not present and the subterranean nest structures were completely removed ; and mound fragmentation combined with fumigation of the subterranean structure, which was only slightly faster but gave 100 per cent. control, can be carried out at any season, does not depend on efficient labour, and does not endanger travel by horse or car by leaving cavities in the veldt. This seemed the only practicable method for use over large areas, and it was further tested in 1947, when work was directed towards finding a method of accelerating the destruction of the mounds. Those with a basal circumference of less than 6 ft. were easily levered up after chopping in at the base, but larger ones were harder and had to be broken down gradually, which was slow and laborious. They could be broken down without difficulty after they had been split by explosives, but this method was costly and did not eliminate the need for fumigation, since few of the termites were killed by the explosion. It was found, however, that such mounds could be easily and cheaply cut off at soil level by means of a flexible steel cable looped round the mound and drawn through it by a team of 12–14 oxen ; the cable was kept in position by means of a crowbar driven horizontally into the mound just above it. The mound was then tipped over, and broken down from the soft inside layer. This method proved satisfactory for light or medium infestations where the cattle had time to rest while moving from mound to mound, but not for areas of high infestation, and in these a tracked caterpillar-type tractor was substituted for the draught animals.

The procedure to be adopted when eradicating termites by mound fragmentation and fumigation is described, and the cost is discussed. It is not advisable to cut more mounds than can be dealt with during the day, since if they are left for long, the termites may repair the damage. The mounds are best cut during the afternoon in winter and during the early morning in summer, since most termites are in them at those times and many are killed by exposure to the cold at night or the afternoon heat. Grass and bush both recovered more quickly, and regrowth after rain was more rapid and luxurious, when the fragmented mound material, which is rich in organic matter, was spread on the surrounding veldt.

MARLOTH (R. H.). **The Litchi in South Africa.**—*Bull. Dep. Agric. S. Afr.* no. 286, 15 pp., 4 figs., 7 refs. Pretoria, 1947.

This bulletin contains a brief note on the few pests known to attack litchee in South Africa. *Argyroploce peltastica* Meyr. oviposits on the fruit and 2–5 per cent. may be damaged by the larvae, which enter through breaks or weak spots in the shell. Infested fruits are difficult to detect during grading and packing. The false codling moth [*A. leucotreta* Meyr.] also attacks litchee, but its incidence is usually low. Fruit-fly infestations have been reported from Natal.

McClean (A. P. D.). **Some Forms of Streak Virus occurring in Maize, Sugar-cane and wild Grasses.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 265, [2+]39 pp., 22 figs., 10 refs. Pretoria, 1947.

Streak viruses isolated from naturally infected maize, Uba sugar-cane and certain grasses in South Africa were compared by studying their host range, the reactions of the plants to them, and their rate of development in maize. *Cicadulina mbila* (Naudé) was used as the vector. In addition to the Uba virus [*R.A.E.*, A **13** 393] and the severe form of maize streak [**19** 134], which is here designated form A, several new forms were found, and the more important characters of each are described. The A virus causes severe and permanent disease in maize, *Digitaria horizontalis* and *Eleusine indica*, but the Uba virus was also transmitted to maize and *E. indica*, and is probably sometimes responsible for the milder forms of disease observed in these plants. The other forms do not appear to be of economic importance. They included a virus termed the B form of maize virus, which produces a permanent disease of a mild type in maize, *D. horizontalis* and *E. indica* and, like the A form, was transmitted with difficulty to sugar-cane, in which it caused a transient infection. The Uba virus afforded no protection to maize against the A or B maize viruses, but the B virus conferred a high degree of protection against the A virus.

Stubbings (W. A. K.). **Studies on the Bionomics and Control of the Pear-bud Mite** (*Eriophyes piri*, **Pag.**).—*Sci. Bull. Dep. Agric. S. Afr.* no. 270, [2+]92 pp., 36 figs., 78 refs. Pretoria, 1947.

The leaf-blistering form of *Eriophyes pyri* (Pgst.) and the form that infests the fruit buds [*cf. R.A.E.*, A **27** 409 ; **36** 82] both occur in South Africa. The bud form is well established in the main pear-growing areas of the western Cape Province [*cf.* **12** 234], where it is of considerable economic importance ; it has also been reported from the eastern Cape Province, the Transvaal and Natal, and doubtless occurs wherever pears are grown in the Union. The leaf-blistering form is not common, and has been reported sporadically on pear from the Cape Province and the Transvaal ; it has also been observed in South Africa on apple and quince. Investigations on the identity, seasonal history and control of the bud form were begun by the author in 1932, and the following is based on his summary of the results.

The difference in seasonal history between the bud-infesting and leaf-blistering types of *E. pyri* are discussed, and a comparison is made between systematic characters of mites from blisters and from damaged buds. It is concluded that the type causing injury to the fruit buds should be regarded as a distinct form of *E. pyri*.

The bud-infesting form of *E. pyri* (pear-bud mite) is free-living on pear trees between the time of bud-burst in spring and the time when the newly formed buds become loose enough to permit the mites to enter them. Relatively little injury is caused at this stage. No deep penetration of the buds normally occurs until differentiation takes place in December. From this time onwards, the mites breed and feed in the fruit buds, progressively penetrating deeper and deeper until the flower parts are reached. Many fruit buds are killed and many others injured by the activities of the mites during winter. The economic damage caused depends on variety, size of mite population, and number of fruit buds present.

Owing to the protected situation of the mites in autumn and winter, the relatively early infestation of fruit buds and the absence of heavy winter migration from infested to healthy buds, autumn and winter spraying has proved ineffective. In the case of moderately heavy infestations, the timely

application of a spray of winter oil emulsion has been found to decrease injury by promoting early and vigorous growth of the flower parts and advancing the blossoming date.

It is shown that heavy mortality of pear fruit buds can occur independently of bud-mite attack. Such mortality occurs in warm winters, and is apparently one of the characteristics of the condition known as delayed foliation. The symptoms of " climatic " bud injury are similar to those of bud-mite injury, and fruit-bud mortality can often be attributed to a combination of these two factors. The theory is advanced that the abscission of protective structures and flower parts of fruit buds through climatic injury is due to the excessively high rate of respiration and transpiration experienced by fruit buds between the times of differentiation and blossoming in warm winters. The damage to fruit buds from bud-mite attack is due to the direct effect of feeding and the abnormally heavy rate of respiration of the plant tissues following mechanical injury. It is concluded that any practices tending to conserve the reserves of the tree in general, and fruit buds in particular, would help to prevent both forms of injury.

The effectiveness of spraying against the pear-bud mite at the cluster stage is questioned on the grounds that many of the mites are not exposed to spray treatment at this stage of tree development. Many fruit buds, both healthy and unhealthy, are unopened at the " cluster-bud " stage owing to unevenness of blossoming and to heavy bud-mite infestation, the latter type harbouring large numbers of mites. Spraying at a later stage of tree development with lime-sulphur is considered undesirable, owing to the injurious effects of this material on pear foliage and fruit, particularly when applied in combination with lead arsenate.

A satisfactory experimental technique for spring spraying experiments was worked out. It was found that, when the randomised block lay-out is used, eight replications of the 1-tree plot unit are desirable, and that a random sample of forty " spur " fruit buds (ten from each tree quadrant) represents the plot adequately in respect of bud infestation. The " blossoming " method (determination of percentage of fruit buds failing to blossom) proved unsatisfactory for collecting data in seasons of delayed foliation.

As a result of extensive field experiments with sulphur compounds against the mite, it was found that elemental sulphur of a suitable degree of fineness gives better results than lime-sulphur, as the sulphur film deposited by sprays of the former is of a more permanent nature than the film of colloidal sulphur resulting from the latter. Neutral wettable sulphur is preferable to other types of elemental sulphur on account of its cheapness and ease of production and transport. Wettable sulphur is most effectively applied against the pear-bud mite after blossoming is completed and all infested fruit buds have disintegrated and dropped. It is less effective when applied near the middle of December, when many mites have penetrated new-season fruit buds deeply enough to be protected from the effects of the sprays.

As summer oil emulsion cannot be used within three weeks of a sulphur spray with safety, experiments were undertaken to develop methods of pear-bud mite control for use in conjunction with summer oil and fixed-nicotine spray programmes against *Cydia* (*Carpocapsa*) *pomonella* (L.). It was found that the addition to three or more of the spring sprays against *C. pomonella* of summer oil emulsion at 1 per cent. resulted in effective control of the mite, and that nicotine sulphate at 1 : 400 is effective against it when applied in conjunction with a casein-lime spreader.

The compatibility of materials of proved effectiveness against the pear-bud mite with different spray programmes against *C. pomonella* is discussed, and the most effective measures indicated with due regard to the control of other prevalent orchard pests.

TOOKE (F. G. C.). **Beetles injurious to Timber in South Africa. A Study of their Biology, Prevention and Control.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 293, 95 pp., 22 pls., 2 graphs, 62 refs. Pretoria, 1949.

This bulletin on the beetles that infest timber in South Africa and their control replaces an earlier one [*R.A.E.*, A **34** 11] and has been extended to include a few additional species, none of great economic importance, additional information on some species, notably *Ernobius mollis* (L.) [**37** 268] and *Hylotrupes bajulus* (L.), and a section on general preventive and control measures based on work in South Africa and elsewhere [*cf.* **25** 669 ; **33** 84 ; **36** 107, 414 ; **38** 261, etc.]. It is there stated that the approved concentration of pentachlorophenol in solutions for the treatment of timber is not less than 5 per cent. [*cf.* **34** 12 ; **36** 107]. Pretreatment to give 0·07–0·1 lb. pentachlorophenol per cu. ft. timber and a minimum sapwood penetration of one-third inch is recommended for protection against *H. bajulus* and *Lyctus brunneus* (Steph.) and should also afford some protection against termites. Tentative recommendations based on work in progress in South Africa are given for the pretreatment of timber with solutions containing 5 per cent. copper naphthenate (approximately 0·5 per cent. copper) in white spirit or in a mixture of equal parts of white spirit and power kerosene. The recommended minimum absorptions are 0·025–0·04 lb. copper per cu. ft. for wood for interior use ; the sapwood penetration should be not less than one-third inch for mill-work and joinery and three-quarter inch for structural timbers. The cold dip immersion method [**36** 107] is satisfactory for the protection of conifer sapwood from wood-boring beetles, but solutions should be applied under pressure to hardwoods and to give protection against dry-wood termites.

Laboratory investigations on the development of *H. bajulus* are recorded ; they indicate that it can exist over a wider range of temperatures and humidities than was at first thought likely [**34** 12], and its distribution to inland areas is therefore possible. Owing to the drier conditions inland, however, its development would be prolonged and damage would be likely to be less. The beetles emerge during November–March in South Africa, and peak emergence takes place in December at Port Elizabeth and in January at Cape Town. Heat treatment of infested roof timbers [*cf.* **21** 214] is difficult to apply in South Africa and does not protect against re-infestation. The best treatment for this purpose is a solution of 5 per cent. pentachlorophenol in white spirit with an auxiliary solvent, applied as a spray under pressure ; it has been used in Cape Town with marked success.

Keys for the identification of larvae and adults of common species or groups of timber pests, based on morphological characters and on the damage caused by them are reproduced in an appendix [*cf.* **37** 268], and the current regulations for controlling and preventing the spread of *H. bajulus* and *Kalotermes* (*Cryptotermes*) *brevis* (Wlk.) are given in another.

STOFBERG (F. J.) & ANDERSSEN (E. E.). **Effects of Oil Sprays on the Yield and Quality of Navel and Valencia Oranges.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 296, [1+]19 pp., 3 figs., 7 refs. Pretoria, 1949.

Prior to 1933, fumigation with hydrocyanic acid gas was in general use for the control of Coccids on *Citrus* in South Africa, but following indications of resistance to this fumigant by red scale [*Aonidiella aurantii* (Mask.)] in the Kat River Valley (eastern Cape Province) [*cf. R.A.E.*, A **22** 725], oil sprays were adopted as a supplementary measure. Serious adverse effects on sprayed trees were reported from various parts of the country, however, and investigations on the influence of oil on yields and composition of orange fruits were begun in 1938 and continued for 7–8 years at two places representing different

conditions of soil and climate. The effect of an application of 1½ or 2 per cent. heavy-medium oil or 2 per cent. light oil in December–January or April was tested on both Valencia and navel oranges, that of two applications of 2 per cent. heavy-medium or light oil in December or April on Valencia oranges, which were picked in September, and that of one application of the 2 per cent. sprays in early July on navel oranges, which were picked in May.

In both varieties, the oil had deleterious effects on the yield, the contents of total soluble solids and of acid [*cf.* **30** 437], the colour of the fruits and, to a less extent, the sugar-acid ratio and the vitamin C content. These effects were most marked in the case of the heavy-medium oil, and most important in the case of the yield and content of soluble solids in the juice. Yields of both varieties were reduced in some seasons when the sprays were applied later than March ; July applications of heavy-medium oil reduced the yield of navel oranges in the following season. The content of solids was not greatly affected by the date of application, but the reduction in navel oranges was greater in some years when heavy-medium oil was applied in April than when it was applied earlier. Two applications, with the second as late as April, reduced the yield and considerably reduced the content of solids in the juice of Valencia oranges. The chief risk in the use of oil sprays is the reduction in the content of solids. As a result, picking may have to be delayed until the minimum content required by export regulations is reached, and this may not occur, especially in navel oranges, before the fruits drop.

None of the treatments produced cumulative effects, but residual effects on yield and fruit colour were noted in the case of navels. Some leaf drop generally occurred after spraying, and although it could not be attributed to any of the treatments, it was most severe during warm weather.

Lea (A.). **Laboratory Tests with Baits containing Benzene Hexachloride against Locust Hoppers.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 300, 16 pp., 4 figs., 5 refs. Pretoria, 1949.

The following is based on the author's summary and conclusions. In view of promising reports on the use of BHC (benzene hexachloride) in baits against locusts and the existence in South Africa of a large stock of prepared arsenical bait (3 per cent. sodium arsenite in maize bran), experiments were undertaken to determine whether crude BHC could be added to the arsenical bait, preferably after diluting the latter with sawdust, to produce a cheap and more efficient bait for locust control. In laboratory experiments in which hoppers of *Locusta migratoria migratorioides* (R. & F.), were offered a choice of bait and normal food for a uniform period and then kept in observation cages for mortality counts, 0·5 per cent. BHC in bran was greatly superior to the arsenical bait. A bait of 0·5 per cent. BHC in a mixture of equal volumes of sawdust and the arsenical bait, the sodium-arsenite content of the mixture being 1·8 per cent., gave good results when compared with the arsenical bait alone, especially with regard to speed of action, but was considerably less effective than the bait of 0·5 per cent. BHC in bran. Sawdust by itself proved a poor carrier, though good kills were obtained when it was poisoned with a high concentration of BHC.

The chief cause of the relative ineffectiveness of the mixed bait was demonstrated in comparative tests of the palatability of sodium arsenite and BHC to hoppers of *L. m. migratorioides* and *Locustana pardalina* (Wlk.), in which the hoppers were given the choice of dusted and untreated leaves or poisoned and unpoisoned bran. The quantities of BHC baits consumed were much greater than those of the arsenical baits, the difference being significant, and equal to or (in the case of *L. pardalina*) greater than those of unpoisoned material, although the toxic action of BHC was so rapid that feeding might be

expected to cease as soon as its effects were felt by the hoppers. It can be assumed that arsenical baits are relatively repellent, probably owing to some scorching effect on the mouth-parts that inhibits further feeding. BHC seemed to be attractive to *L. pardalina*. It is concluded that the sodium arsenite in the mixed baits prevented the hoppers from ingesting as much BHC as they would have done in its absence. In experiments with bran baits containing only BHC, concentrations of 1 and 0·2 per cent. were less effective than 0·5 per cent., and it is concluded that BHC stimulates feeding at 0·5 per cent., is slightly repellent at 1 per cent., and too weak to be toxic or insufficiently stimulating to induce the locusts to consume a quickly lethal amount at 0·2 per cent.

On the basis of these investigations, field trials against *L. pardalina* with the mixed bait of 1·8 per cent. sodium arsenite and 0·5 per cent. BHC in equal volumes of bran and sawdust is recommended. There is even a possibility that the mixed bait may be superior to one containing only BHC in the field in that the sodium arsenite may deter the more ravenous hoppers from eating all the bait before the others have an opportunity of feeding.

**Plant Pathology.**—*Rep. Dep. Agric. Bermuda 1947* pp. 10–12. [Hamilton] 1948.

Bedford (E. C. G.). **Report of the Plant Pathologist 1948.**—*Op. cit. 1948* pp. 13–24. 1949.

Bedford (E. C. G.). **Report of the Plant Pathologist.**—*Op. cit. 1949* pp. 11–19. [1950.]

Groves (G. R.). **Report of the Assistant Director of Agriculture.**—*T.c.* pp. 7–10.

The first three of these reports deal mainly with the introduced Coccids, *Carulaspis* (*Diaspis*) *visci* (Schr.) and *Lepidosaphes newsteadi* (Šulc), on Bermuda cedar (*Juniperus bermudiana*) and their biological control [*cf. R.A.E.*, A **37** 37; **38** 85]. Of parasites and predators of *C. visci* introduced into Bermuda in 1947, those that became established in that year were the Coccinellid, *Lindorus lophanthae* (Blaisd.) and possibly *Aphytis* sp., though a species of *Aphytis* parasitic on *C. visci* may already have been present. *C. visci* occurred over three-quarters of Bermuda in 1947 and increased rapidly in the more recently infested eastern and western parts of the islands in 1948, when hundreds of trees were defoliated and killed. A survey at the end of 1938 indicated that it was present on every Bermuda cedar throughout the islands. In the central area, however, it appeared to be controlled on many trees by the combined effect of parasites and *L. lophanthae*, though some heavy infestations still persisted.

From 12th April to 31st December 1948, 9,091 introduced predators of five species, of which over half were *Lindorus lophanthae*, were liberated against *C. visci*. One larva each of *Cephaloscymnus occidentalis* Horn and an unidentified Nitidulid of the genus *Cybocephalus* were recovered, while *Chilocorus bipustulatus* (L.) and *Zagloba ornata* (Horn) did not become established. *L. lophanthae* was liberated mainly in areas in which it had been absent or scarce, and adults and larvae in all instars were seen feeding on *Carulaspis* in every month from May to December. The Coccinellid occurred throughout the chain of islands during the summer, and was found on nearly every infested tree by the end of the year, though it was sometimes absent on individual heavily infested branches, on which *Carulaspis* was rapidly increasing despite a high percentage of parasitism. Two severe hurricanes in September and October caused extensive damage to the trees but did not appear to affect *C. visci*, except on foliage that had been killed by salt spray. Adult parasites,

though not larvae and pupae in their hosts, were killed, and there were temporary reductions in the population of *Lindorus* following both hurricanes.

At the beginning of 1949, dense populations of *Carulaspis* suitable for the liberation of predators were difficult to find. By the end of May, many trees had produced healthy new growth and some in the central districts bore crops of berries. The prospects of control by *L. lophanthae* appeared very promising, but it became evident during the summer, when hot dry weather also adversely affected many of the surviving trees, that it was not sufficient to prevent heavy infestation. Colonies of the scale on the tips of the last growth of new foliage appeared to be less readily attacked than those on the older growth, and the high summer temperature may have favoured the increase of the scale more than that of the predator. It was obvious that some additional control factor was required if any of the trees were to be saved.

Further introductions and liberations of predators were made during the year. The species introduced comprised *L. lophanthae*, *Cybocephalus* sp., *Z. ornata*, *Microweisea suturalis* Schwarz, *Lotis nigerrima* Csy., *L. neglecta* Muls., *Pharoscymnus exiguus* Weise, *Cephaloscymnus occidentalis* and *Telsimia* sp., of which the last six were reared on *Carulaspis visci* in the laboratory. Larvae of *Telsimia*, *L. neglecta*, *Pharoscymnus* and *Cephaloscymnus* were recovered from branches on which adults had been placed under cloth bags a few weeks previously. In all, 453,506 individuals of all nine species were released, of which 317,557 were reared in California and the remainder in Bermuda, some of them on *Pseudaulacaspis* (*Aulacaspis*) *pentagona* (Targ.) on potato. Larvae and adults of *Telsimia* and *L. nigerrima* were recovered six months after liberation, and *Cybocephalus* and *Microweisea* once, three months after liberation. *Telsimia* was the only species recovered from several liberation sites, and it appeared to be the most promising of the four, though it was not known whether any of them had become established on *Carulaspis*. Details of the releases are shown in tables.

*Lepidosaphes newsteadi* was not very injurious in 1947 and had become scarce by the latter part of 1948. It was even scarcer in 1949, but two isolated infestations were found, one in Warwick, where one tree was heavily infested, and one in Somerset. Examination of foliage from the former area showed that *Lindorus lophanthae* had destroyed 28 per cent. of *Lepidosaphes*, probably because the scales were intermingled with *Carulaspis*. Several dead *Lepidosaphes* were filled with sporangia of the Chytrid fungus, *Myrophagus ucrainica*, which was thought possibly to have been the main factor in control. In February and March, shipments of the migratory form of the predacious mite, *Hemisarcoptes malus* (Shimer), were received from California on 235 Coccinellid beetles (mostly *Chilocorus* spp.), which were liberated with the mites on them on trees infested by *L. newsteadi*. *H. malus* had previously been released in 1946 [*cf.* **37** 37], but was not recovered from Bermuda cedar, though in January 1949 it was found feeding on the eggs of *L. beckii* (Newm.) on *Citrus*. Foliage of *Pinus sylvestris* infested by *L. newsteadi* and *Leucaspis loewi* Colv. was received from Switzerland and kept in emergence boxes. Of the parasites obtained, 1,048 *Prospaltella aurantii* (How.) were released during March and April in areas where *L. newsteadi* was present, and smaller numbers of *Aphytis mytilaspidis* (LeB.) and *Azotus* sp. were liberated there and in Paget, where *Carulaspis visci* was abundant.

No unusual insect damage to crops occurred in 1947. In 1948, *Gnorimoschema operculella* (Zell.) was scarce on potato in the field during May and June, and it was difficult for parasites introduced against it to become established. In most cases, the crops were lifted before the end of June, and larvae were found in all fields where potatoes were left lying on the ground. Larvae of *G. operculella* parasitised by *Chelonus phthorimaeae* Gah., *Copidosoma koehleri* Blanch., *Bracon* (*Microbracon*) *gelechiae* Ashm. [*cf.* **37** 38] and *Omorgus*

*phthorimaeae* Cushm. were dispatched by air, without food, from a laboratory in California and arrived in excellent condition. The parasites emerged after arrival, and nearly 400,000, including all four species, were liberated on potato and tomato in six localities between 5th May and 5th July. Except in the case of *Omorgus*, which was allowed to mate in the laboratory before liberation, the boxes containing the emerging parasites were placed on stakes in the field. Recoveries were subsequently made from larvae from potatoes, but the identity of the parasites was not known. Miscellaneous pests recorded included *Ceratitis capitata* (Wied.), which caused considerable loss of grapefruit in one orchard in August, *Phylloxera vitifoliae* (Fitch), which infested grape-vine leaves, and *Peregrinus maidis* (Ashm.), which was abundant on maize in one locality during November. Other pests of *Citrus* comprised *Phyllocoptruta* (*Eriophyes*) *oleivorus* (Ashm.), which blemished the fruit ; *Icerya purchasi* Mask., which was eventually controlled by *Rodolia cardinalis* (Muls.) ; *Coccus hesperidum* L., which was attended by numerous ants, probably *Pheidole megacephala* (F.) ; *Laphygma* (*Xylomyges*) *eridania* Cram., which completely destroyed the leaves of a few young trees ; and *Lepidosaphes beckii*, which was controlled by oil sprays. In July, *Pseudaulacaspis pentagona* was found heavily infesting oleander (*Nerium oleander*) on a property at Somerset. Branches of the infested plants had been defoliated and killed by the scale, which was not being adequately controlled by its parasite, *Aphytis* (*Aphelinus*) *diaspidis* (How.). Engorged females and unfed examples of a mite thought to be *Pediculoides ventricosus* (Newp.), were observed on nearly all the pupae of the latter, and were obviously attacking them. In January 1949, however, low parasitism of the scale by *Aphytis* in another locality did not appear to be due to the mite, only three females of which were found, and most of the pupae were healthy.

Miscellaneous pests recorded in 1949 included *Eriococcus araucariae* Mask. on *Araucaria robusta*, *Pinnaspis strachani* (Cooley) on *Hibiscus rosa-sinensis*, *Chrysomela polita* L. on cabbage, and *Murgantia histrionica* (Hahn), which was widespread on various crucifers and proved susceptible to benzene-hexachloride dust and spray in the laboratory. *Tyrophagus* (*Tyroglyphus*) *castellanii* (Hirst) was observed beneath *Comstockiella sabalis* (Comst.) on *Sabal bermudiana* at Paget and appeared to be predacious on it. During September, 255 examples of *Chilocorus angolensis* Crotch, which is predacious on *Coccus hesperidum* in South Africa, were received from California and liberated on two trees against soft scales.

A shipment of potatoes received from Canada in 1948 was found after it had been distributed to have been infested by *Leptinotarsa decemlineata* (Say). A reward was offered, and six living adults and 25 dead ones were recovered. Pests intercepted in 1949 included *Aspidiella hartii* (Ckll.) and *Pseudococcus citri* (Risso) on yams [*Dioscorea*], *Parlatoria ziziphus* (Lucas) and *Chrysomphalus ficus* Ashm. on *Citrus* budlings and *Vinsonia stellifera* (Westw.) on orchids, all from the West Indies, and *Rhizoglyphus echinopus* (Fum. & Rob.) on tulip bulbs from England. Precautions to prevent the introduction of *Popillia japonica* Newm. were continued, and living adults were found in all three years in ships and aircraft arriving in Bermuda. None was taken in traps set up at various points.

In the course of the Report of the Assistant Director of Agriculture, an affection of banana fruits known as " black tip " is stated to have become severe in many parts of the islands. It had been attributed to the fungus, *Helminthosporium torulosum*, but examination of bunches from six plantations showed that larvae of a moth identified as *Fundella* sp. ? *pellucens* Zell. [*cf.* **34** 104] were present in all the affected bananas, which suggested that the fungus might be only secondary. The trouble occurs from July to September, and bunches produced from October onwards are not affected.

Salt (R. W.). **Time as a Factor in the Freezing of undercooled Insects.**—*Canad. J. Res.* (D) **28** no. 5 pp. 285–291, 2 graphs, 3 refs. Ottawa, 1950.

An account is given of laboratory experiments in which it was shown that undercooling points determined by exposure to a falling temperature gradient are not reliable as a measure of the cold-hardiness of insects. They were carried out mainly on larvae of *Cephus cinctus* Nort., and confirmed by tests on pupae of this sawfly, diapausing eggs of *Camnula pellucida* (Scud.), overwintering larvae of *Loxostege sticticalis* (L.) and *Eurosta solidaginis* (Fitch), and feeding larvae of *Agrotis orthogonia* Morr. It was found that individual insects kept in an undercooled state at a given temperature freeze at irregular intervals, often over long periods of time. Freezing, which is fatal to most insects, is initiated by the formation of an ice-crystal nucleus, and the probability of such a formation depends on the extent of undercooling (temperature), the cold-hardiness of the insect (which is a complex resulting from previous treatment) and time. For a specific degree of cold-hardiness, the probability of freezing at a fixed temperature can be expressed in units of time. Freezing can take place on a rising temperature gradient as well as on a falling one.

It is concluded that unless an overwintering population is adequately protected by its environment and a high degree of cold-hardiness, losses from freezing will take place by degrees during the entire winter.

Wellington (W. G.), Fettes (J. J.), Turner (K. B.) & Belyea (R. M.). **Physical and biological Indicators of the Development of Outbreaks of the Spruce Budworm,** *Choristoneura fumiferana* **(Clem.) (Lepidoptera : Tortricidae).**—*Canad. J. Res.* (D) **28** no. 6 pp. 308–331, 1 pl., 10 figs., 35 refs. Ottawa, 1950.

The following is based on the authors' conclusions from a study of conditions preceding outbreaks, especially in eastern Canada, of the form of *Choristoneura fumiferana* (Clem.) that feeds on spruce and balsam fir [*Abies balsamea*]. Ideal physical conditions for the development of *C. fumiferana* are provided by sunlight and lack of rain. Dry conditions that also provide more sunlight in spring and summer and continued cold in winter are associated more with polar continental air masses than with maritime air masses. An examination of biological and meteorological records for periods when outbreaks of *C. fumiferana* have occurred in north-eastern North America demonstrated the recurrence of several physical and biological phenomena during the three or four years preceding the outbreaks. The annual numbers of cyclonic centres passing through restricted areas, which may be regarded as indices of air mass movements, decreased before outbreaks, which occurred during periods of decreasing or minimal numbers. Rough indices of both moisture and available sunlight are provided by the official precipitation records. They showed that precipitation fell below normal during the period preceding an outbreak and that these droughts were most common in June and July, though spring or autumn droughts were sometimes associated with the summer ones. The radial increments in the basal sections of trees from moderately dry sites decreased during the pre-outbreak periods, presumably in response to decreased precipitation. In areas of Ontario where forests contained much poplar as well as balsam fir, heavy feeding by *Malacosoma disstria* Hb. preceded severe outbreaks of *C. fumiferana*, and there were some indications of a similar association in western Quebec and in New Brunswick. These phenomena occurred together so consistently before outbreaks of *C. fumiferana* that they are considered to be of value as indicators of such outbreaks.

Examination of the available evidence indicates that forest composition is a preparatory cause of outbreaks, but that the immediate cause of the rapid

increase of populations to outbreak proportions in susceptible foci is the relaxation of climatic control. Recognition of the existence of an endemic population throughout north-eastern North America, which reacts to relaxation of climatic control in suitable foci, is considered to be preferable to the assumption of the spread of an infestation over distances of up to 1,000 miles.

HARDY (G. A.). **Notes on the Life-history of the Garry Oak Looper,** *Lambdina fiscellaria somniaria* **Hlst. (Lepidoptera Geometridae).**—*Proc. ent. Soc. B.C.* **46** pp. 13–14. Kamloops, B.C., 1950.

Laboratory studies were made in 1947–48 on the life-history of *Lambdina fiscellaria somniaria* (Hulst) [*cf. R.A.E.*, A **20** 31], which has recently caused great injury to garry oak (*Quercus garryana*) in Victoria, British Columbia. Its immature stages are described. Two pairs of adults were placed in jars, and oviposition took place on 18th September 1947. One female laid 115 eggs and the other 78, scattered either singly or in small groups on lichen, moss, twigs and the sides of the jar. The eggs were kept throughout the winter in an equably cool room temperature. The larvae hatched on 2nd May 1948 and fed on garry oak until three days before pupation. They remained still except when feeding and rested along the midrib on the underside of the leaves or on moss and bark, often with the head shielded from daylight. For pupation, they spin a thin web between two leaves, among the moss on the trunk or on the ground at the base of the tree. Pupation took place on 22nd June and the first adult emerged on 16th July. On 22nd July, larvae in the field had reached about the same stage of development as those in the laboratory on 31st May.

PIELOU (D. P.). **The Effect of Insecticide Applications on the Insect Fauna and Seed Yield of Alsike Clover in southern Ontario.**—*Canad. Ent.* **82** no. 7 pp. 141–160, 7 figs., 28 refs. Guelph, Ont., 1950.

The causes that have led to the reduction in seed production of alsike clover (*Trifolium hybridum*) in southern Ontario since about 1930 are thought to include damage by insects, and investigations were carried out in several localities in 1948 and 1949 to see whether yields could be increased by the use of insecticides. Those used in preliminary tests in 1948 were BHC (benzene hexachloride) at 2 lb. per acre, DDT alone at 0·5 and 2 lb., DDT at 1 lb. with parathion at 0·5 lb., and parathion alone at 0·5, 1 or 2 lb., all applied once as wettable powders in sprays, BHC and DDT at 2·5 lb. per acre applied once as dusts and DDT and parathion at 2 lb. applied twice as dusts. All the treatments resulted in increased yields, but since parathion and BHC were no more effective than DDT and are more toxic to bees, which are essential for pollination, attention was concentrated on the latter material in 1949, when plots were sprayed with 1 lb. DDT as a wettable powder per acre at the bud, half-bloom or full-bloom stage or at the bud and full-bloom stages. There were again increased yields from the sprayed plots. In both years, the increases ranged from 50 to 100 per cent., but since the actual yield, though satisfactory in 1948, was very low in 1949, it is concluded that the use of insecticides is justified only when a good harvest is expected. On the basis of the work, a single application of DDT at 1 lb. actual DDT per acre made at the bud stage is recommended. If treatment is delayed until some blossom has appeared, it should not be carried out when insect pollinators are visiting the flowers.

Extensive collections of insects were made on the various plots throughout the season in 1949, and the numbers of each of 22 species taken from the treated and control plots in one locality at the time of the spray applications are shown in a table. Except for two varieties of *Philaenus leucophthalmus*

(L.), the most numerous at the time of the spray applications was *Tychius picirostris* (F.), which was ubiquitous and abundant, and was the only species found specifically damaging the seed. It is considered that the increased yields in the experiments were mainly due to the control of this weevil, and that the recommendations based on them may not be applicable where some other insect has to be controlled. Following the applications of DDT, all the insect populations were reduced for about five days ; they increased again within ten days, when the detectable residues on the clover were still appreciable, though only about a quarter of their value on the day after application. The fact that the bud spray increased yields more than the others was presumably due to its application at a time when conditions for oviposition by *Tychius* were most favourable.

DOUTT (R. L.) & SMITH (R. A.). **Males and Intersexes in a normally thelyotokous Insect, *Tropidophryne melvillei* Compere (Hymenoptera, Encyrtidae).**—*Canad. Ent.* **82** no. 8 pp. 165–170, 1 fig., 9 refs. Guelph, Ont., 1950.

During studies of the bionomics of *Tropidophryne melvillei* Comp. [*R.A.E.*, A **27** 503], which was introduced into California from Kenya in 1948, this Encyrtid parasitised *Pseudococcus citri* (Risso) and *P. adonidum* (L.), but not *P. gahani* Green, *P. maritimus* (Ehrh.), or *Phenacoccus gossypii* Tns. & Ckll. The egg is deposited singly in the host, and pupation occurs within its mummified body. Reproduction is normally thelytokous but males and abnormal individuals occasionally appeared in laboratory cultures. The male is here described for the first time. The abnormal individuals, which are basically male and show varying degrees of femaleness, are termed intersexes and are discussed in detail with reference to their possible origin.

SELLERS (W. F.) & ROBINSON (G. G.). **The Effect of the Miticide Neotran upon the Laboratory Production of *Aspidiotus lataniae* Signoret as a Coccinellid Food.**—*Canad. Ent.* **82** no. 8 pp. 170–173. Guelph, Ont., 1950.

In the course of rearing various predators (seven Coccinellids and a Nitidulid of the genus *Cybocephalus*) on Diaspine Coccids on potato tubers in the laboratory in California for shipment to Bermuda, where they are being liberated against *Carulaspis visci* (Schr.) [*cf. R.A.E.*, A **39** 148], cultures of *Hemiberlesia* (*Aspidiotus*) *lataniae* (Sign.) were damaged by predacious mites, which led to the premature cessation of crawler production. Observations showed the species involved to be *Hemisarcoptes malus* (Shimer), which was predominant, *Iphidulus* sp., which occurred only occasionally, and *Tyroglyphus americanus* Banks, which became abundant only when the potato tubers began to decompose. The first two appear about two weeks after the tubers are infested with the crawlers, but the population remains low until the scales are lifted for the crawlers to escape, which increases the available food-supply and provides suitable sites for oviposition. *H. malus* then becomes numerous. The mites normally feed on the crawlers, but were also observed to attack mature Coccids, and the migratory form of *H. malus* attacked pupae of the Coccinellid, *Zagloba ornata* (Horn).

Preliminary attempts to control the mites, in which a wettable mixture containing 40 per cent. di(parachlorophenoxy)methane (Neotran), a wettable mixture containing 50 per cent. K6451 [parachlorophenyl parachlorobenzene sulphonate], and an emulsifiable solution containing 25 per cent. di(parachlorophenyl)methyl carbinol (Dimite) at concentrations of 1·701 gm., 1·701 gm. and 1·183 ml. per quart water were applied to cultures of *H. lataniae*, showed that the last two acaricides were too toxic to the mature Coccids to be of value. Neotran killed only those mature Coccids that had settled on others, but

retarded the production of crawlers by an average of two weeks regardless of the stage at which it was applied ; crawlers were killed by it. When a stock of *H. lataniae* in full crawler production and attacked by *Hemisarcoptes malus* and *Iphidulus* sp. was sprayed with Neotran until the excess liquid ran off the tubers, the mite population per ½-inch square was reduced from 60 to 13 in two days and to little more than one in six days. When it was applied to Coccids seven days after they had settled and before the margins of the scales were raised for the escape of crawlers, mite populations were reduced from 16 to one per ½-inch square in two days, and after a further two days only one adult of *H. malus* was found on ten tubers. The migratory form of this mite was present on both treated and untreated tubers at the time of the test, but disappeared from both after two days.

In further tests, the Coccids settled almost as readily on tubers that had been heavily sprayed with Neotran as on untreated ones, but when tubers were sprayed prior to infestation with *H. lataniae* as a routine measure, about half the crawlers did not settle properly and formed a fine wax-like web instead of the usual scale. This effect may have been due to the inert material in the Neotran mixture or to contamination of the spray-gun with DDT. Larvae of *Z. ornata* that were placed on sprayed Coccids and adults that were sprayed directly with Neotran were all unharmed, as also were adults allowed to feed on treated host material, though the widespread use of this procedure led to a marked drop in beetle production, again possibly owing to contamination.

Auclair (J. L.) & Maltais (J. B.). **Studies on the Resistance of Plants to Aphids by the Method of Paper Partition Chromatography.**—*Canad. Ent.* **82** no. 8 pp. 175–176, 3 refs. Guelph, Ont., 1950.

The following is the authors' summary. By the use of paper partition chromatography, qualitative and semi-quantitative analyses were made of free amino acids in plant juice extracts of two varieties of peas and in Aphids [*Macrosiphum onobrychis* (Boy.)] collected on these varieties. Amino acids in plants and in Aphids were extracted with 80 per cent. ethanol by a special technique developed for paper partition chromatography. The results of the analyses show the presence of 11 amino acids in the plant juice extracts and 15 in the pea Aphid extracts. The variety susceptible to pea Aphid attacks contains a higher concentration of amino acids than the resistant variety, with the exception of the amino acid proline.

Jacobson (L. A.), Blakeley (P. E.) & Farstad (C. W.). **Observations on Feeding Habits of First-instar Larvae of the Pale Western Cutworm,** *Agrotis orthogonia* **Morr. (Lepidoptera : Phalaenidae).**—*Canad. Ent.* **82** no. 9 pp. 181–185, 2 figs., 3 refs. Guelph, Ont., 1950.

One of the cultural measures recommended for the control of *Agrotis orthogonia* Morr., which has long been a major pest of cereals in western Canada, is starvation of the young larvae by destruction of self-sown grain and weeds at a critical period [*cf. R.A.E.*, A **35** 108], but since it would be desirable to restrict it to years in which infestation is heavy, a study was made of the feeding habits of the first-instar larvae with a view to estimating populations from plant damage and also to obtain information that might lead to control by chemicals.

Newly hatched larvae were placed on the soil of pots in which wheat was sprouting, 5–40 per 1 gal. pot containing 10 plants. All had entered the soil within an hour, without climbing on the plants, and feeding had begun within 24 hours. The larvae fed on the furled leaves through holes in the coleoptyle below the soil surface, and the damage appeared above ground in the form of

series of regularly spaced holes along the elongating leaf shoot. The holes were paired when feeding took place on a double layer of leaf. Unlike previous records [*cf.* **35** 109], no feeding took place on the surface. Individual larvae continued to feed on a single plant throughout the first instar, and only when several larvae fed on one plant and destroyed it did they move to another. Severance of plants was observed only when the larvae were extremely abundant or large enough to be able to cut through nearly all the growing leaf. The numbers of plants damaged or destroyed are shown in a table. The relation between the numbers of larvae and of damaged plants was not constant, as several larvae sometimes fed on the same plant, though damage increased with the number of larvae per pot. Larval populations cannot therefore be estimated by the number of holes in infested plants, though the severity of the damage may indicate different population levels. These tests and subsequent field observations indicated that crops can survive attack by first- and second-instar larvae. As the first-instar larvae feed below ground, the prospects of control by contact insecticides are limited.

Green (G. W.) & Sullivan (C. R.). **Ants attacking Larvae of the Forest Tent Caterpillar,** *Malacosoma disstria* **Hbn. (Lepidoptera : Lasiocampidae).**—*Canad. Ent.* **82** no. 9 pp. 194–195. Guelph, Ont., 1950.

During field studies on the behaviour of larvae of *Malacosoma disstria* Hb. in Ontario in 1949–50, *Camponotus herculeanus ligniperdus* (Latr.) and *Formica fusca* L. were found to be abundant on the twigs of *Populus tremuloides*, on which the colonies of the Lasiocampid were established. Nests of the ants were common near the bases of trees, and the workers climbed the trees either to forage or to tend Aphid colonies. When one of the foraging ants, which were chiefly *Camponotus* workers, encountered a colony of larvae in any of the first four instars, it immediately carried a larva to the nest, and successive trips were then made until all the larvae had been removed. In 1949, 12 colonies comprising some 1,800 larvae were removed in this manner, and the trees had to be banded to keep ants away until the remaining larvae had reached the fifth instar, when they were too large to be attacked. In the following spring, which was much wetter, the attack was less extensive. Young larvae of *M. disstria* moving about to feed or moult sometimes passed through an Aphid colony tended by ants of either species. The latter attacked and killed the larvae, and whole colonies of *M. disstria* in either of the first two instars were destroyed in this way. Older larvae appeared to withstand these attacks, and though the ants drove them away, they were seldom killed.

Musgrave (A. J.). **A Note on the Dusting of Crops with Fluorescein to mark visiting Bees.**—*Canad. Ent.* **82** no. 9 pp. 195–196, 1 ref. Guelph, Ont., 1950.

In further work in Ontario on the use of fluorescein for marking bees [*R.A.E.*, A **38** 186], an area of weed growth situated 100 yards from a hive and well worked by hive and wild bees was dusted on 21st August 1950 with a mixture of technical sodium salt of fluorescein and talc (1 : 2). Several hours later, when no hive bees were working, a bumble bee taken from the area was found to be contaminated. The material was detected on the bees by killing them in a cyanide bottle and then putting them in a vial of 0·15 per cent. potassium hydroxide in water and observing the result with the unaided eye. It was found on a bumble bee a few hours after the dust was applied, when no honey bees were working, and honey bees taken in the treated area two days later, after dew and very light rain, were distinctly contaminated. Others collected at the hive were unmarked, probably because few of the bees at the hive had

been working the treated area. A further application was then made to the same and to an adjacent area. Collections of bees made at the hive a few hours later and on the following day yielded two contaminated bees.

It was concluded that visiting bees and presumably other insects will pick up fluorescein and carry it some distance and that the treated crop will remain effective for at least 24 hours. The fluorescein clings well to both bees and plants, and as it is fairly persistent, small amounts can be used.

**Service and Regulatory Announcements, January–December 1949.**—*S.R.A., B.E.P.Q.* no. 175, 113 pp. [Washington, D.C.] U.S. Dep. Agric., 1950.

An Announcement relating to the Fruit and Vegetable Quarantine (No. 56) in the United States contains Administrative Instructions (B.E.P.Q. 583) extending the refrigeration treatments hitherto authorised for certain fruits as a precaution against the entry of the Mediterranean fruit-fly [*Ceratitis capitata* (Wied.)] to all fresh fruits imported under permit at any date [*cf. R.A.E.*, A **25** 517 ; **26** 229 ; **37** 226]. It further authorises similar treatment against *Anastrepha* spp., for which exposure to temperatures not higher than 33, 34 and 35°F. for periods of 16, 18 and 20 days, respectively, is required, and removes restrictions on the type of containers to be used for packing.

Quarantine No. 13, which was originally designed to prevent the spread from Hawaii of *Ceratitis capitata* and *Dacus cucurbitae* Coq. [*cf.* **27** 344 ; **29** 499] has been revised in view of the appearance of several other important pests in that Territory, its title being changed to the Hawaiian Fruit and Vegetable Quarantine. The revision became effective on 24th June 1948, and the named pests and disease against which it is directed are *C. capitata*, *D. cucurbitae*, *D. ferrugineus dorsalis* Hend., *Xanthomonas citri* (citrus canker), *Coccus viridis* (Green) (green coffee scale), *Maruca testulalis* (Geyer) (bean pod borer), *Cosmolyce* (*Lampides*) *boetica* (L.) (bean butterfly), *Chilo simplex* (Btlr.) (Asiatic rice borer), *Cryptorrhynchus mangiferae* (F.) (mango weevil), and *Adoretus sinicus* Burm. (Chinese rose beetle). Except as provided in supplemental rules and regulations, it prohibits the movement from the Territory of Hawaii into or through any other Territory, State or District of the United States of all fruits and vegetables, in the natural or raw state, peel of fruits of plants of three subfamilies of Rutaceae, rice straw, mango seeds and cut flowers. An Announcement relating to this Quarantine contains an authorisation (B.E.P.Q. 481, revised) for the interstate movement from Hawaii of papayas, bell-peppers [*Capsicum*], Italian squash and tomatos that have been subjected under supervision to treatment by vapour heat. Saturated vapour at 110°F. accompanied by a fine mixture of water mist and air must be applied to the fruit in such a manner that the temperature at its centre is raised to 110°F. in eight hours and maintained for a further $8\frac{3}{4}$ hours. Eggs and larvae of *Dacus ferrugineus dorsalis*, *D. cucurbitae* and *Ceratitis capitata* are killed by the latent heat given up as the vapour condenses on the fruit, which is cooled immediately after treatment. Wax or paraffin may not be applied to the fruit until the treatment is completed.

Administrative Instructions (B.E.P.Q. 575) relating to Quarantine No. 64 against the Mexican fruit-fly [*A. ludens* (Lw.)] authorise the use under supervision of vapour heat for sterilising grapefruits and oranges to be moved interstate from the regulated area as an alternative to the refrigeration methods already approved [**30** 174]. The temperature at the centre of the fruit must be raised to 110°F. over periods of eight or six hours and be maintained there for further periods of six or four hours, respectively ; where the latter schedule is adopted, the increase in temperature must be rapid during the first two hours and gradual during the next four.

Announcements relating to the Nursery Stock, Plant and Seed Quarantine (No. 37) include an Amendment modifying the limits in size and age above which restricted herbaceous perennials and certain trees and shrubs may not be imported [**37** 227], Administrative Instructions (B.E.P.Q. 576) exempting certain restricted plant material from some of the regulations of the quarantine, and others (B.E.P.Q. 584) exempting sterile cultures of orchid seedlings in glass containers, which are considered harmless as carriers of insect pests and plant diseases, from individual permit requirements.

Announcements relating to Quarantine No. 52 against the pink bollworm [*Platyedra gossypiella* (Saund.)] include B.E.P.Q. 558, second revision, which authorises additional schedules for the fumigation with methyl bromide of cottonseed from lightly infested areas [**37** 376]. These are exposure for 12 hours to 6 and 7½ lb. methyl bromide per 1,000 cu. ft. at temperatures of at least 60°F. and below 60°F., respectively.

An Announcement relating to Quarantine No. 58 restricting the movement of fruit and vegetables from Porto Rico into any other Territory, State or District of the United States [**13** 435] contains amendments permitting the inspection and treatment of aircraft and their contents and of baggage on ships to be carried out immediately prior to their departure from Porto Rico instead of at the port of arrival.

Announcements relating to Quarantine No. 72 against white-fringed beetles (*Graphognathus* spp.) [*cf.* **37** 377, etc.] include a revision extending the regulated area in the United States to include part of a county of Tennessee, where beetles were found for the first time in 1948, and additional areas in Alabama, Florida, Georgia, Louisiana, Mississippi and North Carolina.

This part also includes summaries of the current domestic and foreign plant quarantines of the United States and its Territories and of other restrictive orders under the Plant Quarantine Act [**17** 163], a summary of plant-quarantine import restrictions in Saudi Arabia, revised summaries of plant-quarantine import restrictions in Canada, Indonesia, Japan, New Zealand, Paraguay, Trinidad and Tobago, and Venezuela, and supplements to summaries of restrictions in Chile [**37** 226, etc.], Finland [**25** 517 ; **26** 385 ; **28** 90], France [**38** 53, etc.], Guatemala [**37** 108, etc.] and India [**25** 628 ; **28** 611 ; **29** 349 ; **33** 111].

SMITH (O. J.) & PETERSON (A.). *Microctonus vittatae*, **a Parasite of adult Flea Beetles, and Observations on Hosts.**—*J. econ. Ent.* **43** no. 5 pp. 581–585, 2 figs., 13 refs. Menasha, Wis., 1950.

*Phyllotreta striolata* (F.) (*vittata* (F.)) is a Eurasian species, but has been present in North America for over 150 years. It used to be an important pest of cruciferous crops in the United States, but, except in the south, where it is mainly represented by var. *discedens* Weise [*cf. R.A.E.*, A **27** 373], its importance has decreased during the present century. This is attributed to parasitism by a Braconid described by Muesebeck in 1936 as *Microctonus vittatae*, and an account is given of investigations in 1932, 1948 and 1949 on the incidence, seasonal abundance, distribution and biology of the latter. It is thelytokous, and males are extremely rare. Fertile eggs are deposited within a few minutes of adult emergence, in the thoracic region of the adult flea-beetles. They increase in volume by about 1,200 times during incubation, and at hatching, the trophamnion surrounding the embryo is broken down into component cells, which float free in the host fluids, absorbing fats until they have increased in volume by 3,500 times. These "giant cells" are the chief source of food for the parasite larvae in their final stages and are an excellent indication of parasitism. Superparasitism occurs, but only one parasite completes its development in each host, the others being eliminated at an early stage by cannibalism or

by " enzymatic " secretions of their rivals. The host is rendered sterile, and the full-grown larva forces its way out of the caudal end of the host, invariably killing it, and spins a cocoon soon after. There appear to be 4–5 larval instars, and at 70°F., the egg and larval stages last 5–6 days and about a week, respectively, and development is completed in 18–20 days. The pupal stage lasts 7–20 days according to temperature. The winter is passed in the first larval instar and there are 6–7 generations a year at Columbus, Ohio, as compared with one of the host.

The Braconid has been reared from *P. striolata*, *P. s. discedens*, *P. s. lineolata* Chitt., and *P. bipustulata* (F.), and larvae indistinguishable from it were found in *P. zimmermanni* (Crotch). *P. aerea* Allard is apparently not parasitised in the field, but was attacked in the laboratory ; it is not known whether the parasite could complete its development in this species. *P. bipustulata* and *P. zimmermanni* appear to be the native hosts. Dissections of host material indicated that the range of the parasite coincides with that of *P. striolata*, which includes the eastern half of the United States and southern Canada, but it appears to be less abundant in the southern States. At Columbus, parasitism followed similar trends in all three seasons, reaching a maximum towards the end of July, gradually falling until the end of September and rising abruptly in late autumn. Parasitism of hibernating flea-beetles was high in the winter of 1948–49. The percentage parasitism varied from 12 to 80 in 1932, 20 to 91·7 in 1948 and 21·4 to 56·7 in 1949 and averaged 46·37 for the three years. The relatively low parasitism in 1949 was apparently the result of low host populations. *M. vittatae* was very sensitive to moisture conditions, especially at the time of cocoon spinning and emergence, and excess moisture or dryness resulted in death. Hyperparasites are unknown.

*M. vittatae* is probably the main agent in the control of *P. striolata* in the United States north of the Mason-Dixon line and in southern Canada, and its presence also seems to account for the fact that neither *P. bipustulata* nor *P. zimmermanni* is of great economic importance. *P. striolata* is a pest in China [*cf.* **34** 118] and Japan [**28** 262], and this appears to be due to the absence of *M. vittatae*.

Observations in hibernation cages at Columbus in 1948–49 indicated only 21·2 per cent. winter survival of *P. striolata* ; an average of 57·71 per cent. of the beetles dissected were males. A nematode indistinguishable from *Howardula phyllotretae* was found in *P. striolata* and *P. bipustulata*, the larvae of which develop in subterranean root systems ; it was numerous at Manhattan, Kansas, but rare at Columbus. It was not found in *P. zimmermanni*, but the larvae of this species, which mine in the leaves of their food-plants, were parasitised by the Eulophid, *Pleurotropis phyllotretae* Riley. A larval Trombidiid mite feeds on adults of *P. striolata*, *P. bipustulata* and *P. aerea* during June and July, but appears to cause no deleterious effects.

Fleming (W. E.) & Hawley (I. M.). **A large-scale Test with DDT to control the Japanese Beetle.**—*J. econ. Ent.* **43** no. 5 pp. 586–590, 2 refs. Menasha, Wis., 1950.

An isolated infestation by *Popillia japonica* Newm. was discovered in 1943 at Blowing Rock, North Carolina, where it had evidently been established for several years. The physical features, climate and soil of the district are described. During each year from 1945 to 1948, the adults appeared in late June, reached a peak of abundance about mid-August and were still numerous during September. Oviposition continued as long as beetles were present. Second-instar larvae constituted 33–80 per cent. of the normal overwintering soil population, and a few first-instar larvae were always present.

In the late autumn of 1943, about 25 acres of infested lawn were treated with lead arsenate at the rate of 500 lb. per acre and about 40 acres of pasture and gardens with a dust containing spores of type A milky disease [*Bacillus popilliae*], but after the summer of 1944, it was evident that neither treatment had had much effect on the infestation. In 1945, DDT was applied as a dust to practically all the known infested soil, except that treated with lead arsenate, between 22nd May and 23rd June, and to that previously treated with lead arsenate and nine additional acres in the autumn. In 1947, an additional area found infested in 1946 was treated, bringing the total treated area up to about 257 acres. The dust consisted of technical DDT micronised with an equal weight of pyrophyllite and further diluted with pyrophyllite and tricalcium phosphate to contain 10 per cent. DDT, 87 per cent. pyrophyllite and 3 per cent. phosphate, and it was applied at 250 lb. per acre by tractor or hand-drawn spreaders or broadcast by hand. Analysis of soil samples indicated that no significant amounts of DDT were lost and that very little penetrated beyond a depth of 1·5 inches in two years.

Although many of the larvae were fully grown and had stopped feeding before the main application of DDT, the number of larvae or pupae dropped from 6·6 to 1·9 per sq. ft. in five weeks. Early in August 1945, before the treatment began to affect the new generation, the average density of the 1945–46 brood was 29·9 per sq. ft., whereas a year later the density of the 1946–47 brood was 6·3 per sq. ft., indicating a reduction of 78·9 per cent. in the number of eggs deposited. The treatment eliminated about 75 per cent. of the 1945–46 brood by October and about 90 per cent. by the following June. This comparative slowness of action is attributed to the cool weather that prevails during the summer in this region, which retards development, reduces larval activity and feeding and lengthens the period necessary for obtaining a lethal dose of DDT. Many larvae were found below the poisoned soil layer. The control obtained was well illustrated by the numbers of adults caught in traps, which increased steadily in 1945–48 in untreated areas but fell by 89 per cent. from 1944 to 1948 in the treated ones. Applications of a spray of 2 lb. 50 per cent. micronised wettable DDT per 100 U.S. gals. to deciduous trees, shrubs and vines and of 10 per cent. DDT dust to low-growing plants were also made in 1945 and 1946, but probably killed only a small proportion of the beetles and gave negligible control.

The results obtained in these tests indicated that it would not be possible to eradicate *P. japonica* by means of DDT without retreating areas in which the treated soil layer had been removed or rendered ineffective by cultivation and treating additional local infestations that develop outside the original treated area, which provide fresh sources of spread.

Observations on the effects of the DDT treatment on other forms of life indicated that most of the insects that came in contact with the dust, including other Lamellicorns, were temporarily reduced in numbers, and some, such as ground beetles and cutworms, practically eliminated. Woodlice were killed, but earthworms, slugs, millipedes and centipedes were not affected. There was some mortality of birds, owing to feeding on affected insects, and a few dead toads were found. There was no apparent effect on moles, fish or other aquatic life, or domestic animals and fowls that entered treated areas.

Ivy (E. E.) & Scales (A. L.). **Dieldrin for Cotton Insect Control.**—*J. econ. Ent.* **43** no. 5 pp. 590–592, 1 graph, 2 refs. Menasha, Wis., 1950.

In field-cage and laboratory tests of dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] against pests of cotton at College Station, Texas, in 1949, dusts were prepared by diluting a dust concentrate or wettable powder or by grinding technical dieldrin

with pyrophyllite, and sprays were made from an emulsifiable concentrate or from the technical material dissolved in acetone with polyethylene glycol phenylisooctyl ether as an emulsifier. The percentages of insects killed (in five days unless otherwise stated) were calculated by Abbott's formula [*R.A.E.*, A **13** 331].

When the insects were caged over treated plants in the field, dusts containing 2·5 or 5 per cent. dieldrin or 20 per cent. toxaphene, applied at 10 lb. per acre, killed 81, 95 and 86 per cent. of *Anthonomus grandis* Boh., with no significant difference between them, but 1·25 per cent. dieldrin was significantly less effective (68 per cent. kill). Sprays prepared from the concentrate were as effective as the dusts, but those prepared from technical dieldrin tended to clog the nozzle and were less effective. Both sprays and dusts of dieldrin appeared to be more resistant than toxaphene dust to removal by rain, and the residues from sprays and dusts giving 0·25 and 0·5 lb. dieldrin per acre were more effective than toxaphene at 2 lb. per acre after treatment with 0·25 inch of simulated rainfall ; the addition of commercial adhesives did not increase the effectiveness of the lower dosage of dieldrin. In laboratory tests on the effectiveness of dieldrin against weevils developing inside the squares, infested squares were collected, treated with various dusts and observed for weevil emergence. It was found that dieldrin killed many of the developing forms, 1·25 per cent. being approximately equivalent to 5 or 10 per cent. chlordan, somewhat more effective than 2·5 per cent. chlordan and much more effective than 20 per cent. toxaphene or sufficient benzene hexachloride to give 3 per cent. $\gamma$ isomer.

Dusts containing 20 per cent. toxaphene and 5 per cent. dieldrin killed 92 and 85 per cent. of third-instar larvae of *Heliothis armigera* (Hb.) in field cages, with no significant difference between them, but 2·5 per cent. dieldrin was significantly less effective (57 per cent. kill). After simulated rainfall, sprays or dusts giving 0·5 lb. dieldrin per acre were more effective and 0·25 lb. dieldrin somewhat less effective than 2 lb. toxaphene. Proprietary adhesives increased the effectiveness of the weaker dieldrin dust and spray but did not make them equal to the others. The dusts containing 5 per cent. dieldrin and 20 per cent. toxaphene killed 92 and 85 per cent. of third-instar larvae of *H. virescens* (F.), 95 and 100 per cent. of fourth-instar larvae of *Alabama argillacea* (Hb.), and 21 and 53 per cent. of *Loxostege similalis* (Gn.). Lower concentrations of dieldrin were not tested against *H. virescens* and were much less effective against *A. argillacea*. In laboratory tests, dusts of 20 and 5 per cent. dieldrin and 20 per cent. toxaphene killed 100, 98 and 100 per cent. of third-instar larvae of *Estigmene acraea* (Dru.) in ten days and 2·5 per cent. dieldrin and 20 per cent. toxaphene both gave complete mortality of larvae of *Peridroma saucia* Hb. (*margaritosa* (Haw.)). Dusts containing up to 40 per cent. dieldrin failed to kill more than 29 per cent. of *Aphis gossypii* Glov. in one day and 2·5 per cent. gave only 8 per cent. kill of *Septanychus* sp. in two days, as compared with 67 per cent. for sulphur. The possibility of increases in Aphids and Tetranychids after treatment with dieldrin should therefore not be overlooked.

PARENCIA jr. (C. R.) & EWING (K. P.). **Late-season Control of Boll Weevil and Bollworm with Dusts and Sprays.**—*J. econ. Ent.* **43** no. 5 pp. 593–595, 1 ref. Menasha, Wis., 1950.

Advantage was taken of late-season damage to cotton by *Anthonomus grandis* Boh. and *Heliothis armigera* (Hb.) in central Texas during 1949 to test various dusts and sprays for their control. The weevil was the more important in five experiments. In the first of these, a dust containing 20 per cent. toxaphene with 40 per cent. sulphur, one of 2·5 per cent. dieldrin

[1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and another of 2·5 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] with 5 per cent. DDT and 40 per cent. sulphur, used at 17 lb. per acre in four effective applications between 3rd and 18th August, gave significant control of the weevil, and mixed dusts containing chlordan, DDT and sulphur at concentrations of 7·5, 5 and 40 per cent. and 10, 5 and 40 per cent., applied at 16 and 17 lb. per acre, gave control that was just not significant and just significant, respectively. The toxaphene and dieldrin dusts were significantly better than the chlordan mixtures and dieldrin significantly better than the aldrin mixture. All treatments gave significant control of *Heliothis* and increased the yield of seed-cotton significantly. Dieldrin gave a significantly higher yield than any other treatment.

In the second, the toxaphene, aldrin and two chlordan mixtures were applied six times effectively between 11th August and 5th September at 14 lb. per acre. All reduced the weevil infestation, toxaphene doing so the most, and the aldrin mixture caused a slight increase in populations of *Aphis gossypii* Glov., though no damage was done. Toxaphene and aldrin caused the greatest increases in yield. In the third test, the toxaphene and two chlordan mixtures were applied four times between 29th July and 11th August at 17 lb. per acre, and a mixture containing 2 per cent. γ BHC (benzene hexachloride), 10 per cent. DDT and 40 per cent. sulphur at 16 lb. All reduced the weevil infestation ; the toxaphene and BHC dusts caused the greatest reduction and no increases in Aphids and the latter gave the highest yield. The chlordan mixtures caused slight Aphid increases.

In a field of cotton planted on 22nd June and subjected to a heavy migratory weevil population, plots receiving 12 lb. per acre of the toxaphene dust or of calcium arsenate with 1 per cent. γ BHC in seven effective applications between 16th August and 27th September had 44 and 35 per cent. squares punctured by the weevil, 3 and 4 Aphids per sq. in. of leaf and yields of 1,605 and 1,495 lb. per acre. Untreated cotton nearby did not yield enough to be picked. In another field of June-planted cotton, eight applications between 5th August and 8th September of 7·5 U.S. gals. emulsion containing 0·69 lb. DDT with either 0·34 lb. aldrin, 1·38 lb. chlordan or 1·38 lb. toxaphene per acre reduced weevil damage from 80 to 48, 66, and 59 per cent. and increased the yield from 280 to 1,084, 809 and 873 lb. per acre, respectively.

In the only test in which *Heliothis* was the predominant pest, four applications were made between 13th July and 3rd August of 7·5 U.S. gals. emulsion containing 1 lb. toxaphene, alone or with 0·5 lb. DDT, 2 lb. toxaphene, alone or with 1 lb. DDT, or 1 lb. DDT alone. All but the first reduced bollworm damage and increased the yield significantly, DDT alone and the stronger mixture being the best. Toxaphene alone gave significantly lower yields than any other treatment.

*Anthonomus* and *Heliothis* were of equal importance in the remaining three experiments. In the first, the toxaphene dust applied four times at 15 lb. per acre between 22nd July and 9th August gave better control of the weevil and rather less control of *Heliothis* than a spray of 1·5 lb. toxaphene and 0·75 lb. DDT in 7·5 U.S. gals. per acre applied on the same dates, the spray giving the higher yield. In the second, four applications of a dust containing 2 per cent. γ BHC, 10 per cent. DDT and 40 per cent. sulphur at 14 lb. per acre between 28th July and 13th August gave good control of both insects and increased the yield from 650 to 1,105 lb. per acre, and in the third, this dust gave somewhat better control of the weevil than the toxaphene dust when applied four times at 18 lb. per acre between 30th July and 16th August, but proved inferior against *Heliothis*. The yields were increased from 650 to 1,245 and 1,172 lb. per acre, respectively.

Parencia jr. (C. R.) & Ewing (K. P.). **Comparison of early-season, late-season, and a Combination of early-season plus late-season Insecticide Applications for Cotton Insect Control.**—*J. econ. Ent.* **43** no. 5 pp. 596–598, 2 refs. Menasha, Wis., 1950.

Some insects, including thrips, *Psallus seriatus* (Reut.) and overwintered boll weevils (*Anthonomus grandis* Boh.), damage cotton early in the season every year in central Texas. They often delay the fruiting and maturity of the cotton by two or three weeks, and this leaves the cotton exposed longer to attack from late-season insects such as the weevil and *Heliothis armigera* (Hb.). Several organic insecticides were applied in concentrated sprays or dusts against thrips and overwintered weevils in fields near Waco, Texas, in 1949, and the effect of applications early and late in the season were compared. Dusts containing 20 per cent. toxaphene, 20 per cent. toxaphene with 40 per cent. sulphur, and 10 per cent. DDT, 40 per cent. sulphur and enough BHC (benzene hexachloride) to give 2 per cent. γ isomer were applied at the rate of 10 lb. per acre early in the season and 15 lb. later, and sprays prepared from emulsion concentrates containing 6 lb. toxaphene, 4 lb. toxaphene with 2 lb. DDT and 4 lb. chlordan with 2 lb. DDT per U.S. gal. were applied at 1–2 U.S. pints in 2·5 U.S. gals. per acre early in the season and at 3–4 U.S. pints in 7·5 U.S. gals. later. The early applications were made mainly between 12th May and 8th June, and the late ones between 8th and 29th July. Dusts were applied early in the morning, and sprays during daylight at a pressure of 60 lb. per sq. in.

Plots treated early showed good control of thrips, overwintered weevils and *P. seriatus*, produced twice as many flowers as untreated ones and began to set the crop 2–3 weeks earlier. Although the seasonal weevil infestation was comparatively light, 25–85 per cent. of the squares were punctured late in the season in untreated plots, as compared with 25 per cent. in three of four treated ones. In the fourth treated plot, which adjoined an untreated one, 78 per cent. of the squares were punctured by 22nd July, showing the need for treating at least entire fields early in the season.

Light or medium infestation by *H. armigera* had developed on all the plots by 8th July, when late treatment was begun ; damage was not severe, but was about half as great in plots receiving late treatment as in those receiving no treatment or early treatment only. Plots receiving no treatment and averages of 3·5 early treatments, 5 late treatments or 7·3 early and late treatments produced 1,036, 1,353, 1,415 and 1,496 lb. seed cotton per acre, indicating that early applications may be more economical than late ones in central Texas. Early treatment becomes even more important when the value of early production and harvesting is considered ; late applications, especially on highly productive land, are likely to be needed after the early ones on areas smaller than entire farms or communities. Control of early insects by toxaphene was approximately the same whether a dust or a spray was used.

Smith (W. R.) & Calhoun (S. L.). **Comparative Effectiveness of Aldrin applied at different Times of the Day for Boll Weevil Control.**—*J. econ. Ent.* **43** no. 5 pp. 598–601, 3 graphs, 7 refs. Menasha, Wis., 1950.

The following is based on the authors' summary. A large-scale field test was carried out near Stoneville, Missouri, in 1949, in which aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] was applied by aeroplane nine times between 26th July and 3rd September in an emulsion spray at the rate of 0·2 lb. in 1 U.S. gal. per acre for the control of *Anthonomus grandis* Boh. on cotton. Applications were made at 6 and 10 a.m. and 2 and 6 p.m. to observe the effects of the climatic factors that obtain at different times of the day on the toxicity of the insecticide.

Control was significantly better after the evening treatment than after those in the early morning or afternoon, but not quite significantly better than after that at 10 a.m. There was no significant difference in yield between treatments, as all kept the infestation sufficiently low to prevent a reduction in yield. The treated plots yielded 656–772 lb. more seed cotton per acre than the untreated one. Wind movement, convection currents and dew were suggested as adverse factors contributing to the differences in control.

*Aphis gossypii* Glov. did not develop in sufficient numbers to be of economic importance, and DDT was included in the last three applications to prevent a threatened infestation by *Heliothis armigera* (Hb.).

Gaines (J. C.) & Dean (H. A.). **Effect of climatic Factors on the Toxicity of certain Insecticides.**—*J. econ. Ent.* **43** no. 5 pp. 602–605, 3 graphs, 2 refs. Menasha, Wis., 1950.

The following is largely based on the authors' introduction and summary. Further cage tests were carried out in Texas in 1949 [*cf. R.A.E.*, A **38** 235] in which the effects of climatic factors on the toxicity of sprays and dusts of toxaphene, sprays and dusts containing 3 per cent. γ BHC (benzene hexachloride) and 5 per cent. DDT and sprays containing toxaphene and DDT (2 : 1) to *Anthonomus grandis* Boh. and *Alabama argillacea* (Hb.) on cotton were studied in the greenhouse and laboratory. The sprays were prepared by diluting miscible oil concentrates with water, and a minimum of five dosages was used to establish each dosage-mortality curve. In tests at average daily temperatures of 76–91°F., the BHC-DDT spray was more toxic to *Anthonomus* than the other sprays or the dusts at the 50 per cent. mortality level, whereas at the 95 per cent. level, the toxaphene spray was as toxic as the spray of BHC and DDT. In similar tests with *Anthonomus* at average daily temperatures of 75–103°F., the toxicity of all materials was greater at the higher temperatures and there was little difference in the toxicity of the three treatments containing toxaphene at any level of mortality. The BHC-DDT spray was slightly more effective than the corresponding dust. Exposing the treated plants to sunshine and simulated dews reduced the toxicity of all the insecticides used, but in general, the sprays of toxaphene, alone or with DDT, remained more toxic under these conditions than the toxaphene dust or the BHC-DDT spray or dust.

In tests with *Alabama* at average daily temperatures of 67–77°F., the two sprays containing toxaphene were more effective than the toxaphene dust at the 50 per cent. level, but their superiority was reduced by the low temperatures at the higher mortality levels. The BHC-DDT mixtures were not tested against this insect.

Calhoun (S. L.) & Smith (W. R.). **Control of Boll Weevil, Bollworm, and Cotton Aphid with organic Insecticides applied as concentrated Sprays.**—*J. econ. Ent.* **43** no. 5 pp. 606–610, 2 refs. Menasha, Wis., 1950.

Preliminary experiments were carried out in Mississippi in 1948 to test the efficacy of concentrated sprays applied by aeroplane and ground equipment for the control of insects attacking cotton. Emulsified solutions of DDT, chlordan, γ BHC (benzene hexachloride) or toxaphene and a mixture of organic phosphates containing 40 per cent. TEPP (tetraethyl pyrophosphate) were applied in water at rates giving the same amounts of poison per acre as are usually obtained from dusts. DDT was not used alone, but was included in some of the sprays at a rate giving 1 lb. per acre for the control of *Heliothis armigera* (Hb.).

In the first experiment, sprays were applied by aeroplane at 1·95 U.S. gals. per acre in a field of late cotton on which fruiting was at a peak, although most of the cotton had matured in surrounding fields. Infestation by *Anthonomus*

*grandis* Boh. was heavy and migration was in progress. Toxaphene, BHC, chlordan and a mixture of toxaphene and chlordan (5 : 1) were applied at 2, 0·3, 1 and 1·8 lb. per acre, and DDT was added in the last three applications of BHC and chlordan. Six applications were made at intervals of 4–7 days from 25th August to 22nd September between 3 and 6.30 p.m. TEPP and BHC were applied against *Aphis gossypii* Glov. at rates of 0·1 and 0·3 lb. per acre, respectively, on 24th September. In the second test, toxaphene, chlordan and the mixture of the two were applied at 2, 1 and 1·8 lb. in 2·5 U.S. gals. per acre by aeroplane six times at intervals of 5–6 days between 17th August and 13th September, beginning when 37–56 per cent. of the squares were punctured by *Anthonomus*. DDT was added to the last two applications of chlordan alone. In the third, the sprays were applied with ground equipment at the rate of 5–12 U.S. gals. per acre to give 2·11 lb. toxaphene, 0·55–0·99 lb. chlordan or 1·75 lb. of the mixture per acre six times at intervals of 4–9 days from 6th to 30th August, either in the morning or in the afternoon, but two applications were washed off by rain. The cotton was fruiting heavily, and infestation by *Anthonomus* was high and migration in progress. In the fourth, five applications at the same rates were made in the morning or afternoon with ground equipment between 13th and 26th August, one being washed off by rain. Toxaphene, chlordan, the mixture of the two and BHC were applied at 1·96, 1·18, 2·14 and 0·32 lb. per acre. The cotton had passed the peak of fruiting, and 83–99 per cent. of the squares had been punctured by *Anthonomus*.

All the insecticides applied by aeroplane gave good control of *Anthonomus* ; BHC was the least and the mixture of toxaphene and chlordan the most effective in the first experiment, and toxaphene alone or in the mixture was better than chlordan in the second. In the first, control by all insecticides increased as the season advanced and as the temperatures became lower. BHC and chlordan alone did not control *Heliothis*, but DDT provided effective control when added to them. All treatments caused increases in yield, that for the mixture being greatest. The numbers of *Aphis gossypii* Glov. per square inch of leaf were 0·15 and 0·12 on the untreated and BHC plots, 2·29 and 7 on the plots treated with toxaphene and the toxaphene-chlordan mixture, and 17·4 on the plot in which DDT was added to chlordan in the last three applications. The subsequent application of TEPP and BHC controlled the Aphid under very adverse conditions, the TEPP being then particularly effective. In the second test, chlordan alone permitted an increase of *Heliothis*, which was checked by DDT.

Control of *Anthonomus* was very poor with all insecticides applied by ground equipment, possibly because of rain. Numerous dead weevils were found in treated plots, but no practical control was obtained because of migration. Another contributory factor may have been the necessity for greater dilution of the insecticides in order to obtain plant coverage.

None of the treatments damaged plant tissues or had any apparent effect on growth.

Cressman (A. W.), Munger (F.) & Broadbent (B. M.). **Effectiveness of different Concentrations of Parathion alone and of Oil with Parathion to control California Red Scale.**—*J. econ. Ent.* **43** no. 5 pp. 610–614, 7 refs. Menasha, Wis., 1950.

Previous investigations having indicated that parathion, alone and with oil, was promising for the control of *Aonidiella aurantii* (Mask.) on *Citrus*, field studies were carried out in California in 1948 on the control of the scale with different concentrations of parathion as a 25 per cent. wettable powder, alone and with two concentrations of medium or light oil.

Applications of 4, 6 and 8 oz. actual parathion per 100 U.S. gals. water to a heavily infested lemon grove on 28th September 1948 reduced the numbers of adult female scales from 9·4, 8·1 and 8·1 per three-inch length of grey wood before treatment to 1·94, 1·29 and 0·97 per six-inch length of green wood the following May, indicating rather better control with high concentrations. Spreaders and an acaricide were added in some plots but did not appear to influence scale control. Further treatment with the same concentrations on 2nd June 1949 resulted in 10·4, 2·7 and 1·1 scales per fruit in late September, the differences between treatments being highly significant. On a neighbouring plot sprayed with 1·8 per cent. medium oil in October 1948 and June 1949, infestation in September 1949 was comparable on the fruit and green twigs with that in plots receiving 8 oz. parathion, but considerably heavier on the older wood. Control on plots sprayed with 2 oz. parathion in 100 U.S. gals. 2 per cent. medium oil in October 1948 was at least as good as that on plots sprayed twice with 6 oz. parathion in water. Spring applications of 6 or 8 oz. parathion per 100 U.S. gals. following oil sprays in autumn have also given excellent control of *A. aurantii*.

The citrus mealybug [*Pseudococcus citri* (Risso)] was generally distributed throughout the lemon grove before the first sprays were applied. In August 1949, no mealybugs were found in the parathion plots, but they persisted on trees that had been sprayed with 2 per cent. medium oil in October 1948. Some infestation by the soft brown scale [*Coccus hesperidum* L.] developed in the summer of 1949, particularly in the parathion plots, but it was controlled by parasites by the end of the season. In this and other experiments control of the citrus red mite [*Paratetranychus citri* (McG.)] by parathion was less satisfactory than that obtained by oil sprays, though infestation was greatly reduced for a time. All trees in the parathion plots were sprayed with 8 oz. parathion per 100 U.S. gals. on 25th October 1949, and no adverse tree reactions were observed. Moderate shedding of older leaves was observed in other groves, and heavy shedding from older trees in poor condition and from young trees treated during a prolonged period of wind and low humidity.

When 2 or 4 oz. parathion per 100 U.S. gals. was added to 1 per cent. medium oil sprays applied to lemon on 6th July 1948, the numbers of females of *A. aurantii* were reduced from 2·92 and 3·02 per three inches grey wood before treatment to 1·02 and 0·28 per six inches green wood in January 1950. The same quantities reduced them from 2·8 and 2·36 to 1·18 and 0·26 when added to 1 per cent. special light oil, from 3·25 and 3·21 to 0·48 and 0·3 when added to 1·75 per cent. medium oil, and from 3·46 and 2·88 to 0·65 and 0·22 when added to 1·75 per cent. light oil. On trees treated with 1·75 per cent. medium and light oils alone, there were 1·66 and 1·4 before treatment and 2·03 and 1 after. These results showed that all sprays containing parathion were better than those that did not, with no difference between light and medium oil in corresponding sprays. The differences between the two concentrations of parathion were highly significant, and most marked at the lower oil concentration. The differences between 1 and 1·75 per cent. oil were not significant when they contained 4 oz. parathion and doubtfully significant when they contained 2 oz. There was a tendency for added parathion to increase the oil deposits from sprays containing 1·75 and 2 per cent. oil. Infestation by *Paratetranychus citri* remained low throughout the summer and autumn, but was heavy by the end of February 1950 on all plots. Leaf- and fruit-drop was negligible after all sprays, and no other adverse effects were apparent. However, other experiments showed that whenever oil caused leaf-drop, it was increased by parathion, the differences being more pronounced for light oil than for medium or heavy-medium oil. The addition of 2,4-D [2,4-dichlorophenoxyacetic acid] at 6–8 parts per million of the alkanoamine salt or 4 p.p.m. of the acid equivalent of the ester almost entirely prevented leaf-drop on lemon

but was sometimes less effective on orange. The combinations of oil and parathion had no ill effects on workers applying the sprays.

GAINES (J. C.), IVY (E. E.), DEAN (H. A.) & SCALES (A. L.). **Toxicity of various Sulphur and Phosphorus Compounds applied as Sprays on Spider Mites and Aphids.**—*J. econ. Ent.* **43** no. 5 pp. 614–619, 2 graphs, 9 refs. Menasha, Wis., 1950.

*Aphis gossypii* Glov. and Tetranychid mites often become injurious to cotton after the application of certain organic insecticides, presumably owing to the destruction of their natural enemies. It is stated that the spider mite most commonly found on cotton in Texas and other southwestern States was determined as a new species of *Septanychus* and was referred to as such by Iglinsky & Gaines [*R.A.E.*, A **38** 292] but that further studies indicated that it is close to *Tetranychus opuntiae* Banks. [No comment is made on other records of *Septanychus* on cotton in Texas (**39** 7, 124 ; *cf.* also **38** 328) but the species concerned was presumably *S. texazona* McG. (**39** 102), the type material of which was collected at College Station by Iglinsky.]

The results are given of laboratory tests made at College Station, Texas, to evaluate some of the available sulphur and phosphorus compounds that might be used for mite and Aphid control in a schedule of spray applications for the control of other cotton pests. Miscible concentrates applied as emulsions were used and their relative toxicity was tested against Aphids and adult mites that had been put on seedling cotton plants growing in nutrient solution. Tests of residual toxicity against both Aphids and mites were made by spraying heavily infested cotton plants in pots and exposing them to reinfestation throughout the test period. The different dosages of each insecticide (lb. active ingredient per acre) were plotted against the mortalities, and those giving 50 and 90 per cent. mortality determined from the graphs. The results are given in tables ; the following is based on the authors' summary of them. The order of decreasing toxicity of the phosphorus compounds against both mite and Aphid were tetraethyl pyrophosphate, parathion, diethoxythiophosphoric ester of 4-methyl 7-hydroxy coumarin, a mixture of parathion and its methyl homologue (1 : 4), tetraethyl dithionopyrophosphate, mercurated pentaethyl triphosphate, and octamethyl pyrophosphoramide [also known as bis[bis(dimethylamino)]phosphonous anhydride, etc. (*cf.* **37** 486, 487 ; **38** 191) and for which the common name schradan has been proposed]. The sulphur compounds were not effective against the Aphid, but the order of decreasing toxicity against the mites was 2-(para-tert.-butylphenoxy)-1-methyl-ethyl 2-chloroethyl sulphite, parachlorophenyl phenylsulphone, parachlorophenyl parachlorobenzenesulphonate, 2,4-dichlorophenyl ester of benzenesulphonic acid, and two polysulphide compounds. The 1,1-bis(parachlorophenyl)ethanol was not so toxic to mites as 2-(para-tert.-butylphenoxy)-1-methyl-ethyl 2-chloroethyl sulphite, but was more toxic than the other sulphur compounds. Schradan remained highly toxic for 14 days, indicating either residual or systemic action [*cf.* next abstract]. The sulphite, sulphone and sulphonic acid compounds and the diethoxythiophosphoric ester of coumarin also remained toxic for 14 days but the residual toxicity of the other phosphorus compounds decreased within ten days.

IVY (E. E.), IGLINSKY jr. (W.) & RAINWATER (C. F.). **Translocation of Octamethyl Pyrophosphoramide by the Cotton Plant and Toxicity of treated Plants to Cotton Insects and a Spider Mite.**—*J. econ. Ent.* **43** no. 5 pp. 620–626, 5 refs. Menasha, Wis., 1950.

The results are given of experiments in 1949 showing that schradan (octamethyl pyrophosphoramide [or bis[bis(dimethylamino)]phosphonous

anhydride]) can be absorbed by and translocated in plants so that they are toxic to certain arthropods feeding on them [*cf. R.A.E.*, A **38** 191–193, etc.]. In tests in 1948, parathion, which has been reported to possess this property [*cf.* **37** 300 ; **38** 234], failed to control *Aphis gossypii* Glov., *Anthonomus grandis* Boh., *Heliothis armigera* (Hb.) and a spider mite on cotton plants when applied to the soil at rates of 0·5–2 lb. per acre. Technical schradan, which is a liquid and readily soluble in water, was used in water solution and in dusts made by impregnating a clay carrier with acetone solutions of it, evaporating the acetone and grinding in a ball mill.

In laboratory tests, schradan was added at rates of 1·2–76·8 parts per million to a nutrient solution in which cotton seedlings were grown for a fortnight, after which they were transferred to untreated nutrient solution and infested with *Aphis gossypii* or the mite. All the Aphids died in three days on plants treated with 38·4 p.p.m. and all the mites in two days on those treated with 9·6 p.p.m.

In greenhouse tests, solutions were applied to soil in which infested cotton was growing at rates of 1–256 lb. schradan per acre and the plants were re-infested after 21 days ; the higher dosages were extremely effective against both Aphid and mite within 2–3 days, and dosages of 8 lb. per acre were still very effective after 25 and 50 days. In a further test against the mite, in which the plants were re-infested at intervals, dosages of 25, 50 and 75 lb. per acre were very effective for 53 days and then gradually lost effectiveness, though all the treated plants had lower mite populations than untreated ones for 223 days after the single application. Untreated plants had fewer mites than treated ones after 246 days, possibly because of their poor condition, and new leaves that appeared on treated plants after cutting back contained little or no toxicant 272 days after treatment.

Plants receiving sprays of 1, 2 and 4 lb. schradan in 3 U.S. gals. water per acre on the foliage became toxic to the mite much sooner than those grown in soil treated with 4, 8 or 16 lb. schradan per acre. They remained toxic for 26 days, by which time the soil treatment had begun to take effect, though the spray treatment with 4 lb. per acre was still much better than the corresponding soil treatment. All spray treatments and the soil treatment at 4 lb. per acre were ineffective 51 days after application, but the other soil treatments were still highly effective.

In preliminary tests on seed treatment, cottonseed was soaked for two hours on 15th April in water containing 0·5, 1 and 2 per cent. schradan, drained and immediately planted in sand. The plants were uprooted 6, 13 and 35 days later and infested with mites and Aphids. A complete kill of both was obtained with all treatments. In another, the seed was mixed with schradan dusts, freed from excess and planted in sand. The plants were transferred to nutrient solution after six days, and infested with mites and Aphids. After five days, 0·2, 0·4, 0·8, 1·6 and 3·2 per cent. dusts resulted in 21, 56, 74, 94 and 89 per cent. mortality of mites, and 0·8, 1·6 and 3·2 per cent. dusts in 8, 72 and 91 per cent. mortality of Aphids. Plants removed from the sand after 33 days seemed to have lost their toxicity. When the amounts of schradan applied to the seed in 1, 0·5 or 0·25 per cent. solution or 25 per cent. dust were expressed as the amount applied per acre (calculated on the basis of sowing at 20 lb. seed per acre), 0·08 and 0·18 lb. schradan per acre in solution gave almost complete control of the mite and 0·04 lb. was effective against adults but not against nymphs. Dosages of 0·05, 0·1 and 0·2 lb. per acre in dusts were effective against adults but not against nymphs.

In field-plot tests, solutions of schradan at 1, 2, 4 and 8 lb. per 100 U.S. gals. per acre were sprayed uniformly over the soil and month-old cotton plants growing in it. The plants were lightly infested by Aphids at the time of treatment, and all rates of application gave good control of them in five days. The

plots were then reinfested with Aphids, and all treatments gave good reductions, varying with the rate of application. Three weeks after treatment the plants were infested with mites, and the four rates caused reductions in these of 76, 88, 94 and 100 per cent., respectively, in 12 days.

When cottonseed, some of which had been delinted, was soaked for four hours in 2, 1, 0·5 and 0·25 per cent. solutions of schradan, drained and planted at the rate of 50 lb. per acre, giving rates per acre of 0·62–0·06 lb. schradan for the delinted seed and 0·5–0·05 for the other, all treatments kept the Aphid at a very low level for 36 days.

In subsidiary tests with various schradan treatments, the compound had little or no effect on adults or larvae of *Anthonomus grandis*, larvae of *H. armigera*, *Alabama argillacea* (Hb.) and *Estigmene acraea* (Dru.), nymphs of grasshoppers or adults of *Psallus seriatus* (Reut.) and *Scaphytopius irroratus* (Van D.). *Trialeurodes abutilonea* (Hald.) increased on treated plants in the greenhouse, and the garden webworm [*Loxostege similalis* (Gn.)] on cotton grown from treated seed or sprayed in the field. Cotton plants were killed by 0·5 per cent. schradan in nutrient solutions and stunted by 0·25 per cent. ; no injury was observed at 0·125 per cent. In soil tests with potted plants, schradan at 256 and 128 lb. per acre caused leaf shed and stunting, but the plants partially overcame the injury. No injury could be detected at lower dosages. Seed treatment with 2 per cent. solutions caused some reduction in stand, but lower concentrations were not injurious.

No fumigant action from treated plant tissue [*cf.* **37** 487–488] was detected when a plant sprayed three weeks before with schradan at 4 or 160 lb. per acre, of which the lower rate gave complete kill of mites, was enclosed in a sealed fumigation chamber with an untreated plant infested by mites. There was no evidence of an increase in the toxicity of schradan as a consequence of its translocation by the plant, since only about a tenth of the toxicant absorbed by the plant from nutrient solution could be accounted for when the plant was ground and filtered and the filtrate tested on mites.

Smith (F. F.), Fulton (R. A.) & Hall (S. A.). **Toxicity of organic Phosphates to the Two-spotted Spider Mite and the Foxglove Aphid.**—*J. econ. Ent.* **43** no. 5 pp. 627–632, 6 refs. Menasha, Wis., 1950.

An account is given of further experiments in which organic phosphorus compounds were tested in aerosols propelled by methyl chloride against various arthropods in greenhouses [*cf. R.A.E.*, A **38** 221] and of preliminary tests in which schradan (octamethyl pyrophosphoramide) was also applied in other ways. The following is based on the authors' summary. Aerosols containing HETP (hexaethyl tetraphosphate), TEPP (tetraethyl pyrophosphate) or tetraethyl dithiopyrophosphate in methyl chloride, applied at low dosages, were more toxic to a non-resistant strain of *Tetranychus bimaculatus* Harvey than to *Macrosiphum solani* (Kalt.) (*Myzus convolvuli* (Kalt.)) in overnight exposures and were not toxic to *Trialeurodes vaporariorum* (Westw.) and *Pseudococcus citri* (Risso). At the dosages recommended for commercial greenhouses, they were toxic to all four species. Tetraisopropyl pyrophosphate and tetraethyl monothiopyrophosphate were essentially equivalent to tetraethyl dithiopyrophosphate in their toxicity to *M. solani* and *Tetranychus bimaculatus* at comparable dosages. At the dosage used in commercial greenhouses (0·25 gm. per 1,000 cu. ft.), TEPP in aerosols gave a maximum kill of *M. solani* and *T. bimaculatus* during the first 15 minutes after release, and began to lose its toxicity to the Aphid after 30 minutes and to the mite after the second hour. Tetraethyl dithiopyrophosphate at 0·5 gm. per 1,000 cu. ft. killed *T. bimaculatus* more rapidly than TEPP at 0·25 gm. and remained highly toxic for about four hours in the unventilated greenhouse.

Aerosols containing 5 per cent. schradan applied at the rate of 0·5 gm. toxicant per 1,000 cu. ft. gave slow but complete mortality of *Tetranychus* on bean and rose in three days. Mites transferred to treated foliage within 11 days were also killed. In commercial greenhouses, resistant and non-resistant strains of the mite were controlled by 2–4 applications at intervals of three weeks. *Aphis gossypii* Glov., *Anuraphis padi* (L.) (*helichrysi* (Kalt.) ), *Rhopalosiphum rufomaculatum* (Wils.), *M. solani*, *Myzus persicae* (Sulz.) and *Macrosiphum solanifolii* (Ashm.) and resistant and non-resistant strains of *T. bimaculatus* were killed on the foliage of plants growing in soil that had been treated with water solutions of schradan (1 : 600) ; toxicity appeared to persist for 2–5 weeks. There was no evidence of toxicity to *Epilachna varivestis* Muls. (adults or larvae), *Hercinothrips femoralis* (Reut.), *Phenacoccus gossypii* Tns. & Ckll., *Trialeurodes vaporariorum*, *Tarsonemus pallidus* Banks or *Hemitarsonemus latus* (Banks). No injury to bean, chrysanthemum, potato, lily, rose, *Saintpaulia* or turnip occurred at the dosages adequate for complete kill of *Tetranychus* and the Aphids (22·5 ml. solution per 6-in. pot), but the first three were slightly injured at four times the required dosage. The same solution sprayed on the foliage of bean, chrysanthemum, lily and rose gave complete kills of Aphids and *Tetranychus* on sprayed foliage and also on new foliage that was not sprayed. Three applications of the solution to China aster [*Callistephus chinensis*] infested by *Macrosteles divisus* (Uhl.), the vector of the aster yellows virus, caused no reduction in infection in field plots. The compound was translocated in a few days from turnip leaves dipped in the solution to untreated leaves on the same plant in May, as evidenced by toxicity to *Myzus persicae*, but the process was much slower in October.

Neiswander (C. R.), Rodriguez (J. G.) & Neiswander (R. B.). **Natural and induced Variations in Two-spotted Spider Mite Populations.**—*J. econ. Ent.* **43** no. 5 pp. 633–636, 2 refs. Menasha, Wis., 1950.

Following the discovery that *Tetranychus bimaculatus* Harvey on rose in a commercial greenhouse and on bean and tomato at the Ohio Agricultural Experiment Station differed in colour and in susceptibility to an acaricide but not in morphology, populations of mites from the two sources were transferred to different food-plants and subjected to different acaricidal treatments. It is concluded from the results that rather wide variations exist among populations of *T. bimaculatus*, the rate at which a population develops as well as the ease with which it can be destroyed with acaricides being influenced by the food-plant. A population feeding on rose is usually more resistant to acaricides than one on beans, and a population on beans is more resistant than one on tomato. When the mites are transferred from one food-plant to another, certain characteristic changes occur during the period in which 2–3 generations develop. A population subject to the action of a dilute acaricide for three or more generations developed a partial immunity to that material, and it appears that against such a heterogeneous organism as *T. bimaculatus* it may be necessary to change acaricidal materials at frequent intervals in order to ensure effective control. A study of the influence of food-plant composition on susceptibility or resistance of these forms to acaracides and a genetic study of the species should yield valuable information.

Underhill (G. W.). **Timing early Sprays for Summer Control of European Red Mite.**—*J. econ. Ent.* **43** no. 5 pp. 637–639, 1 fig. Menasha, Wis., 1950.

The following is based on the author's introduction and summary. Investigations on the general habits and seasonal development of *Paratetranychus pilosus* (C. & F.) on apple were carried out for three years in Virginia in order

to determine what conditions may lead to serious outbreaks and how to recognise them, the practical relationship, if any, between the brood development and habits of the mite and the regular spray programme, and the value of an acaricide in the petal-fall and other early orchard sprays. The first winter eggs hatched at about the time that apple buds showed pink and the last at about petal-fall. A large survival of winter eggs led to outbreaks causing serious bronzing of the foliage in the early season, a moderate survival to outbreaks causing serious bronzing in mid-summer, and a light one to outbreaks often causing bronzing in late autumn. The early outbreak was the most serious from the standpoint of injury caused, but was followed by mere traces of winter eggs the next season. The late one was least serious but resulted in a large population of winter eggs.

Good control of mite outbreaks early in the season was obtained with a single application of an acaricide, made at petal-fall. An additional application in the pink spray or the first or second cover spray did not add much to the control obtained during this time. The second cover spray ranked next in efficiency, and the pink spray last. The results indicated that the petal-fall spray is a good alternative for the dormant or delayed-dormant oil treatment. The acaricides tested were dinitrocaprylphenyl crotonate, the dicyclohexylamine salt of dinitro-o-cyclohexylphenol and parathion. All gave satisfactory control, parathion proving the best.

CHAMBERLIN (F. S.). **Insecticidal Control of Aphids and other Insects on Shade-grown Tobacco.**—*J. econ. Ent.* **43** no. 5 pp. 640–641, 4 refs. Menasha, Wis., 1950.

In field tests in 1949 on shade-grown tobacco in Florida and Georgia [*cf. R.A.E.*, A **38** 252], the main objectives were to determine the strength of parathion dust needed for control of *Myzus persicae* (Sulz.) and other Aphids and to obtain preliminary data on the value of dusts containing mixtures of parathion and DDT against the other main insect pests. A survey in the area indicated that dusting with 1 per cent. parathion at about ten-day intervals, supplemented with occasional spot treatments, nearly always gave satisfactory control of the Aphids.

Dust mixtures containing 0·5, 1 and 2 per cent. parathion with 10 per cent. DDT were made from wettable powders diluted with a specially prepared tobacco dust from which most of the water-soluble constituent had been removed. Cigar-type tobacco plants were set in the field on 15th March, the central 25 in each plot coming from a seed bed heavily infested with *M. persicae* and the remaining 200 from a treated bed believed to be free of Aphids, and the dusts were applied at about 8 lb. per acre from 17th March. The total Aphid counts for the season indicated that the two stronger dusts applied weekly and all three applied twice a week were highly effective with no significant difference between them, but the weakest dust gave significantly less control than the others when applications were made weekly, so that at least 1 per cent. parathion should be used when applications are made at intervals of a week or longer.

Experiments in 1948 had shown that applications of 1 per cent. parathion, alone or with 10 per cent. DDT, gave good control of cutworms on young shade-grown tobacco, and that the combined dust gave significantly better control than parathion alone. In 1949, the plants were attacked by cutworms, mainly *Feltia subterranea* (F.), soon after they had become established. Feeding injury became apparent throughout the test area and caused a loss of 10 per cent. of the stand on untreated plots, but ceased on all treated plots before any appreciable damage was done. Observations made throughout the growing season in the experimental field and in commercial plantings indicated that

shade-grown tobacco treated with mixtures of parathion and DDT on a seasonal basis sustained no injury from *Epitrix hirtipennis* (Melsh.) or *Halticus bracteatus* (Say), both of which were generally prevalent on untreated tobacco and vegetables. The mixed dusts gave some apparent control of *Protoparce sexta* (Johan.) during the first part of the growing season, but this proved insufficient to check the growing infestation as the season advanced, and observations on commercial plantings confirmed that these materials do not control heavy infestations on shade-grown tobacco.

In these tests, the operators handled and applied the materials without apparent ill effects, and only three cases in which parathion apparently caused slight and temporary illness occurred among operators of hand dusters throughout the whole area in 1949.

Dudley jr. (J. E.) & Bronson (T. E.). **Six Years Field Tests with insecticidal Dusts against Pea Aphid.**—*J. econ. Ent.* **43** no. 5 pp. 642–644, 7 refs. Menasha, Wis., 1950.

During 1944–49, several new insecticides were tested in Wisconsin against *Macrosiphum onobrychis* (Boy.) (*pisi* (Kalt.)) on peas, and in this paper the results are given of tests in which the toxicants were applied separately ; mixtures of two or more materials were also tested, but in general the results were not outstanding. The insecticides were applied as dusts at about 35 lb. per acre with a power-duster equipped with a 24-foot boom travelling at the average rate of 2½ miles an hour, and a 45-foot trailer was used except when the plants were wet with dew or the wind velocity was not more than 4 miles an hour. Pyrophyllite was the diluent in 1944 and talc was the main diluent in the other years for all materials but parathion, which was diluted with a clay. Only one application of a given material was made each year, and Aphid infestation was determined at intervals for 1–10 days after treatment.

A dust of 5 per cent. mechanically mixed DDT and a derris dust (0·75 per cent. rotenone) with 2 per cent. mineral oil were used as standards of comparison. The derris dust gave satisfactory Aphid control in most years, but over the six-year period, DDT was usually superior and exhibited a greater uniformity in reducing infestation. A dust of 5 per cent. DDT prepared with a volatile solvent (acetone, carbon tetrachloride or trichloroethylene) was the most effective material in the two years in which it was tested, and others of 2·5 per cent. DDT prepared in the same way and 1·25 per cent. DDT prepared with a non-volatile solvent, each tested for three years, were about as effective as 5 per cent. mechanically mixed DDT ; 1·25 per cent. DDT prepared with a volatile solvent, tested for two years, was less effective than the other DDT dusts. In three years' tests, 0·5 per cent. parathion was superior to 5 per cent. mechanically mixed DDT. It was equal in effectiveness to 0·25 per cent. parathion in 1948, and 1 per cent. in 1949. DDD (TDE [dichlorodiphenyldichloroethane]) at 5 per cent. was as good as any other material in the one year in which it was tested. Tetraethyl pyrophosphate was tested in the last three years, the concentration being reduced from 5 per cent. in 1947 to 0·75 per cent. in 1949, when it gave highly satisfactory control and was practically as good as DDT or parathion. Hexaethyl tetraphosphate, nicotine sulphate, benzene hexachloride, methoxy-DDT (methoxychlor) and *Ryania* were unsatisfactory at the concentrations tested.

Rainwater (C. F.) & Ivy (E. E.). **Factors influencing Compatibility of Benzene Hexachloride and Parathion with Calcium Arsenates.**—*J. econ. Ent.* **43** no. 5 pp. 645–648, 8 refs. Menasha, Wis., 1950.

Laboratory experiments were carried out at College Station, Texas, on the degree to which BHC (benzene hexachloride) and parathion are compatible

with regular commercial calcium arsenates in dust mixtures [*cf. R.A.E.*, A **38** 254] and the influence of storage conditions on the effectiveness of the various mixtures. Eight commercial calcium arsenates and two special calcium arsenates were mixed with 1 per cent. parathion or enough technical BHC to give 1 per cent. γ isomer and stored in tightly stoppered glass bottles at 74–96°F., in paper bags at 140°F. and 5–15 per cent. relative humidity or in paper bags at 74–96°F. and 100 per cent. relative humidity. Tests against *Aphis gossypii* Glov., after storage for 1, 5–6 or 20 weeks showed that some of the commercial calcium arsenates were extremely incompatible with both BHC and parathion. The special calcium arsenates and certain of the commercial ones appeared to be more compatible than others, but no instance of complete compatibility under all storage conditions was found. High temperature and high humidity both caused rapid loss of effectiveness of the mixtures.

In tests with special calcium arsenate containing various concentrations of free lime, the loss of effectiveness of γ BHC was greatest in those with the highest lime concentrations ; mixtures prepared from the pure γ isomer lost effectiveness more rapidly and more completely than those prepared from the technical material containing the other isomers. When 1 per cent. of the γ isomer was mixed with 6 per cent. of the other isomers separately in a calcium arsenate selected for incompatibility, the percentage losses in effectiveness after two weeks were 86, 66, 65 and 0 for the mixtures with the β, α, ε and δ isomers, respectively. None of these four isomers by themselves in calcium arsenate showed appreciable toxicity to the Aphid.

Tomlinson jr. (W. E.), Marucci (P. E.) & Doehlert (C. A.). **Leafhopper Transmission of Blueberry Stunt Disease.**—*J. econ. Ent.* **43** no. 5 pp. 658–662, 2 figs., 3 refs. Menasha, Wis., 1950.

A disease that was shown in 1942 to be caused by a virus has become a serious threat to the cultivation of blueberries in New Jersey. It is characterised by the stunting of branches and leaves, leaf discoloration and failure to produce a normal number of fruit buds. A search for insect vectors was begun in 1943. Leafhoppers were suspected, but other Hemiptera, Coleoptera and Thysanoptera were included in transmission tests. Evidence of insect transmission was first obtained in 1944 with mixed miscellaneous insects collected from diseased plants, including *Empoasca fabae* (Harr.), *Graphocephala coccinea* (Forst.), *Agallia constricta* Van D. and unidentified Jassids. In 1945, *Scaphytopius magdalensis* (Prov.) and *S. verecundus* (Van D.) from blueberry were tested together, but no transmission was obtained. In 1946, the test insects were allowed to feed on diseased bushes and then transferred to healthy ones ; three of four plants exposed to colonies of *S. magdalensis* and *S. verecundus* developed stunt disease, two in 1947 and one in 1949. In tests begun in 1947, in which 46 species of insects were tested, no plants but those exposed to colonies of *S. magdalensis* and *S. verecundus* pre-fed on diseased bushes developed the disease, and in tests begun in 1948 with 35 insects, again only plants exposed to pre-fed colonies of these two species were affected. All the 17 positive transmission tests with known insects were with *S. magdalensis* and *S. verecundus*, although a species of *Gyponana* was also present in one instance, and 11 per cent. of the exposures to the two species resulted in the development of the disease. The two leafhoppers were not tested separately, as the adults are not easily distinguishable.

*S. magdalensis* occurs throughout the eastern United States and in eastern Canada ; although present as far south as Florida and Georgia, it is essentially a northern insect and can be expected wherever its food-plants are found. *S. verecundus* is a more southerly species, not previously recorded north of North Carolina. In New Jersey, nymphs and adults were collected on four species of *Vaccinium* (wild and cultivated blueberries and cranberry) and on

Ericaceae of four other genera. Both species are most commonly found in low moist situations and feed mainly on leaves or leaf-bearing twigs in the lower, shaded portions of the bush. Eggs are laid only between the epidermal surfaces of the leaves, usually low on the plant. The winter is passed in the egg stage in fallen leaves and there are two generations in the year. The eggs begin to hatch in late April or early May, and adults of this generation appear in early June and are most numerous in late June and early July. Nymphs of the summer generation are present from early July to late September, and adults appear about the middle of August and reach a maximum in late September and early October.

The prompt removal of diseased plants gives effective control when the rate of infection is low, but is probably impractical without supplementary control of the vectors when infection is 5 per cent. or more. The planting of resistant varieties of blueberry is not practical at present, but may become so. The application of sprays of 2 lb. 50 per cent. DDT or methoxy-DDT (methoxychlor) per 100 U.S. gals. at intervals of three weeks during 1948 and 1949 caused little reduction of leafhopper populations in young, non-bearing fields because the population was largely migratory, but in a heavily infested, mature field it caused 95 per cent. reduction of *S. magdalensis*, *S. verecundus*, *Graphocephala coccinea* and *Gyponana* sp. in two-acre plots, so that spraying of the entire field and a strip of the surrounding vegetation should give nearly perfect control.

WOODRUFF (N.). **Interactions between Temperature and Toxicity of four Insecticides applied by Injection.**—*J. econ. Ent.* **43** no. 5 pp. 663–669, 7 figs., 12 refs. Menasha, Wis., 1950.

In the experiments described, the chemicals in distilled water and distilled water alone were injected into nymphs and adults of *Oncopeltus fasciatus* (Dall.) that had been anaesthetised with carbon dioxide, after which the bugs were placed in petri dishes containing a small quantity of milkweed seed [*Asclepias*] and moisture, stored at temperatures of 10, 15, 22 and 29°C. [50, 59, 71·6 and 84·2°F.], and observed daily for seven days. The amount injected into each insect was 3 microlitres. The mortality of water-injected nymphs and adults increased with rises in temperature, the nymphs being the more susceptible.

When nicotine, a poison that kills slowly, was injected at concentrations of 0·4, 0·28, 0·2 and 0·14 per cent. by weight, paralysis occurred immediately, and it is assumed that temperature affected recovery rather than speed of action or penetration of the chemical. Both death and recovery were more rapid at the higher temperatures than at the lower ones, but survival of adults increased and that of nymphs decreased as the temperature rose. Adults appeared to be more resistant than nymphs to the effects of nicotine under the same conditions.

DDT, the other slow-killing poison tested, differed from nicotine in that paralysed bugs rarely recovered. However, there was substantial recovery of treated nymphs and adults at the highest temperature. DDT was injected in colloidal suspension at concentrations of 1, 0·7, 0·5 and 0·35 per cent. by weight, which proved to be rather high for accurate interpretation, particularly for the nymphs. Recorded mortality of both nymphs and adults was low at the lowest temperature, because most of the affected individuals had not died at the end of the observation period. It increased as the temperature rose to 71·6°F. but decreased at the highest temperature.

Sodium azide, which is an inhibitor of oxidising enzymes, kills more rapidly than the other materials tested ; there were few paralysed individuals at any time. It was used in solution at concentrations of 0·7, 0·5, 0·35 and 0·25 per cent. by weight, and gave about equal kills of adults at the four different temperatures, though the mortality of nymphs was greater at the highest

temperature than at the lowest. It was less effective against nymphs than against adults, and permitted more survival than the other materials at the lower dosages. At the additional temperatures of 5 and 2°C. [41 and 35·6°F.], the recovery of nymphs was equal to that at the two highest temperatures. Further lowering of the storage temperature did not result in additional recovery. The temperature for optimum recovery of treated nymphs was 50°F. Storage temperatures of 35·6–84·2°F. had no effect on adult mortality or recovery.

Rotenone in a colloidal suspension was injected at concentrations of 0·0175, 0·0125, 0·0087 and 0·0062 per cent. When injected into the blood streams of insects, it is at least 20 times as toxic as nicotine and about 50 times as effective as DDT or sodium azide. It resembled the azide in its speed of action, but paralysed a considerable proportion of the bugs ; recovery from this was rare. Mortality was again too high for accurate comparison, but the toxicity to both nymphs and adults was greater at the highest than at the lowest temperature. Only at the latter was there appreciable recovery of either adults or nymphs.

It is concluded that speed of action generally increases with temperature, but that mortality does not always do so, some chemicals showing a negative temperature coefficient. The opposite effects of temperatures on nymphs and adults of the same species treated with nicotine may possibly be the results of different physiological systems.

METCALF (R. L.) & MARCH (R. B.). **Properties of Acetylcholine Esterases from the Bee, the Fly and the Mouse and their Relation to Insecticide Action.**—*J. econ. Ent.* **43** no. 5 pp. 670–677, 4 figs., 22 refs. Menasha, Wis., 1950.

Since it is desirable to develop insecticides that are of low toxicity to beneficial insects and mammals, and since diisopropyl p-nitrophenyl thiophosphate has been proved to inhibit brain cholinesterase of house-flies (*Musca domestica* L.), to which it was toxic, but not that of honey bees, to which it was not toxic [*R.A.E.*, A **38** 317], the effects of phosphate and carbamate anticholinesterases on cholinesterase from these insects and white mice were compared.

Breis of bee heads, fly heads and mouse brains were homogenised in a buffer, phosphate inhibitors in acetone solution or carbamate inhibitors in aqueous solution were added, and the flasks were flushed with nitrogen and carbon dioxide (95 : 5). The acetylcholine or other substrate solution was added ten minutes later and the flask shaken for five minutes to reach equilibrium. The amount of carbon dioxide produced in 30 minutes was then compared with that from a standard without inhibitor. When diisopropyl fluorophosphonate was used, a reaction period of four hours was allowed before substrate addition because of its slower rate of combination with cholinesterase. The probits of the percentage inhibition from different concentrations of inhibitor were plotted against the logarithms of the molar concentrations and the 50 per cent. inhibition value was determined by inspection. The numbers of micromoles of acetylcholine hydrolysed per mg. brain per hour were 2·5, 11 and 0·356 for female bees and flies and male mice, respectively, when no inhibitor was added. The concentration of cholinesterase in fly brain is thus about 30 times that in mouse brains.

Diisopropyl p-nitrophenyl thiophosphate showed remarkable selectivity, being almost inactive against cholinesterase in bee and mouse brain but 1,000 times as active against that in fly brain, whereas parathion (diethyl p-nitrophenyl thiophosphate), di-n-propyl p-nitrophenyl thiophosphate and paraoxon (diethyl p-nitrophenyl phosphate) were of fairly comparable activity against the three enzymes. Tetra-n-propyl dithiopyrophosphate and diisopropyl fluorophosphonate were much more nearly of the same degree of activity to all three than tetraisopropyl dithiopyrophosphate and tetraisopropyl pyrophosphate,

which were much more effective against fly-brain cholinesterase than against that in bee and mouse brains. EPN (ethyl p-nitrophenyl thiobenzenephosphonate [*sic*, *cf.* **39** 12, 107]) was about 25–50 times as effective against fly- and bee-brain cholinesterase as against mouse-brain cholinesterase, and this difference in activity is correlated with lower mammalian toxicity. In general, the relative toxicities of all the compounds closely parallelled their anti-enzyme activity *in vitro*, and it seems possible that there are specific differences in the protein structures of various true or specific cholinesterases from the central nervous systems of different animals. The data suggest stereochemical differences in the enzyme structures of bee-, fly- and mouse-brain cholinesterases. Combination of the phosphate ester with bee- and mouse-brain cholinesterase appears to be hindered by the crowding of the groups of atoms round the central phosphorus atom ; this hindrance is evident with isopropoxy groups, is increased by the combination of thiophosphoryl and isopropoxy groups and reaches a maximum with phenoxy, isopropoxy and thiophosphoryl groups.

The relative concentrations of eserine (physostigmine sulphate) and N-p-chlorophenyl-N-methylcarbamate of m-hydroxyphenyltrimethyl ammonium bromide required for 50 per cent. enzyme inhibition of fly- and bee-brain cholinesterase were closely comparable, but dimethyl carbamate of (2-hydroxy-5-phenylbenzyl)-dimethyl ammonium chloride was about 100 times as effective against fly-brain cholinesterase as against bee-brain cholinesterase. It was about 1,000 times as effective as the bromide carbamate against fly-brain cholinesterase, about equally effective against bee-brain cholinesterase and about one-fortieth as effective against that in mouse brain. These results are further indications of specific differences in the chemical properties of the cholinesterase in the central nervous systems of different animals.

Differences were also shown in tests on the relation of substrate to cholinesterase activity. Acetylcholine had similar optimum concentrations for the three species and caused pronounced inhibition of activity when present in excess, due to the formation of an enzyme-substrate complex, and benzoylcholine was only very slightly hydrolysed by any of the three cholinesterases, but acetyl-β-methylcholine was hydrolysed by bee-brain cholinesterase in the manner of a typical non-specific esterase, with no inhibition of the reaction by excess substrate, by fly-brain cholinesterase only very slightly and by mouse-brain cholinesterase at a rather similar rate to acetylcholine with similar inhibition by excess substrate.

Tests with paraoxon and eserine showed that these compounds were about equally effective in inhibiting the action of bee-brain cholinesterase on either acetylcholine or acetyl-β-methylcholine and that pretreatment of the enzyme for 30 minutes with eserine exerted considerable protective action against further cholinesterase inhibition by paraoxon. In general, the same was true of the protective action of pretreatment of fly-brain cholinesterase with eserine against inhibition by paraoxon when acetylcholine was the substrate.

CARTER (Walter). **The Oriental Fruit Fly : Progress on Research.**—*J. econ. Ent.* **43** no. 5 pp. 677–683, 7 refs. Menasha, Wis., 1950.

The author describes the organisation and scope of a co-operative investigation on the bionomics and control of *Dacus ferrugineus dorsalis* Hend. begun in 1948 with reference not only to control in Hawaii but also to the prevention of spread of infestation to the United States [*cf. R.A.E.*, A **38** 316]. The research undertaken comprised investigations on biology and ecology, biological control, chemical control, area control (the development of techniques to eliminate incipient infestations on the mainland), and the treatment of commodities, and reports on the preliminary work are included in this paper.

The investigations resulted in the liberation in Hawaii of six of 36 introduced species of parasites and the establishment of three from Malaya. Methyl eugenol was found to attract the males from more than half a mile downwind against a wind of 10 miles an hour ; large numbers were caught in traps baited with this material, and the use of these might give control by preventing the fertilisation of the females. Females were also attracted by high concentrations of this compound. EPN (ethyl p-nitrophenyl thionobenzene phosphate [*sic, cf.* **39** 175, etc.]), dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene], parathion and DDT were the best of the insecticides applied to leave toxic deposits in laboratory tests, but gave less than 75 per cent. control in small-plot tests of sprays on banana. Dieldrin and aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] were ten times as effective as DDT in aerosol fogs, lindane [at least 99 per cent. γ benzene hexachloride] and chlordan 4–5 times as effective and Dilan (a 2 : 1 mixture of technical 2-nitro-1,1-bis(p-chlorophenyl) butane and 2-nitro-1,1-bis (p-chlorophenyl) propane) more effective, but no insecticide entirely prevented oviposition.

Experiments in connection with area control showed that the insects fly long distances, marked males being recovered 20 miles from the point of liberation, so that reinfestation is common. In urban areas, which in Hawaii are rich in host-fruits, dilute DDT fog sprays reduced adult populations by 98 per cent. when there was little reinfestation. The export of papayas, tomatos, bell-peppers [*Capsicum*] and zucchini [Italian squash] after treatment with vapour heat [*cf.* **39** 156], and of fresh pineapple after fumigation with methyl bromide for six hours at 2 lb. per 1,000 cu. ft., was approved. Methyl bromide was also tested extensively on papayas, tomatos and cucumbers, but the results obtained were not considered sufficiently good to justify recommendations. Experiments with the Capacitron (a machine using accelerated electrons), dielectric equipment that uses high-frequency waves, and gamma rays were begun. Life-history studies showed that the fruit-fly can infest 128 plants, including practically all the economic fruits grown in Hawaii and many in California, but it is possible that some of these are used only in the absence of suitable ones. This was the case with the infestation of flowers of *Vanda* orchids [*cf.* **38** 316]. Eggs were found on the flowers, and larvae developed in special circumstances, as a result of which the flowers were exported only after fumigation with methyl bromide. Careful study showed, however, that the commercial flower does not constitute a danger to mainland agriculture, and the fumigation requirement was removed.

It was found that a male takes ten days and a female seven to become sexually mature and that mating occurs at night, so that an important limiting factor may be low night temperatures. The pupal stage lasted 60 days or more at low temperatures, and eggs and larvae survived in fruit floating in fresh water for seven days.

SHENEFELT (R. D.). **Control of the Pine Root Collar Weevil.**—*J. econ. Ent.* **43** no. 5 pp. 684–685, 1 ref. Menasha, Wis., 1950.

*Hylobius radicis* Buchanan, notes on the habits of which are given [*cf. R.A.E.*, A **32** 426], has caused severe damage to Scots pine [*Pinus sylvestris*] in central Wisconsin. Injury has frequently occurred on Norway and jack pine [*P. resinosa* and *P. banksiana*] planted near Scots pine and occasionally on Austrian and white pine [*P. nigra* var. *austriaca* and *P. strobus*]. Near Wisconsin Dells, many Scots pines planted in the last 25 years were killed by the weevil. In one mixed pine plantation established in 1926, Scots pine was heavily infested by 1947, but Norway pine was almost free from damage.

Control measures were tested on a strip of Scots pines remaining in an area where felling had been begun because of the infestation. The trees were pruned to a height of about four feet, and in June 1948 various emulsions were poured on the bark round the trunk about an inch above the ground at about 1 U.S. pint per tree. In October, the trees were examined by stripping the bark from the base and larger roots, and the amount of girdling was estimated. All showed outward evidence of having been infested. The percentage mortality due to treatment was estimated from the numbers of larvae per inch of girdling on treated and untreated trees ; adults were rare and were not considered. BHC (benzene hexachloride) at a rate equivalent to 1 lb. γ isomer per 1,000 trees was the most effective (97·9 per cent. mortality), 25 per cent. propylene dichloride gave 93·9 per cent. mortality alone, 73·9 per cent. with 0·5 oz. 2,4-dinitro-6-cyclohexylphenol per U.S. gal. and 87·2 per cent. with 5 per cent. dichloroethyl ether, and 25 per cent. ethylene dichloride gave 80·2, 75·8 and 63·6 per cent. in corresponding emulsions. Chlordan and DDT at rates equivalent to 5 lb. per 1,000 trees gave 78·8 and 61·1 per cent. One of the many larvae examined had an external parasite feeding on it, and a parasite larva and a cocoon were found in a connecting chamber. Masses of nematode larvae were numerous in the galleries, but there was no evidence that they were parasitic.

Nearly 1,000 other Scots pines treated with the BHC emulsion showed almost complete control of *Hylobius*, and other experiments indicated that it retained its toxicity in the soil for at least two years. It appeared to be the best material for efficiency of control, ease of handling and persistence, but the cost of trimming and application is too great for any but valuable trees.

Plummer (C. C.) & Shaw (J. G.). **Toxicity of Spray Oils to immature Forms of Citrus Blackfly.**—*J. econ. Ent.* **43** no. 5 pp. 686–690, 2 refs. Menasha, Wis., 1950.

The following is largely based on the authors' summary. In tests in Morelos, Mexico, on the toxicity of oils to eggs of *Aleurocanthus woglumi* Ashby, small branches of sour lime trees with uniform numbers of egg spirals on the leaves were sleeved after being sprayed with emulsions containing 0·83, 1·25 and 1·67 per cent. light, light-medium or medium emulsive spray oils. Light-medium oil at 1·67 per cent. containing 4·5 oz. powdered cubé root (5 per cent. rotenone) per U.S. gal. oil was also applied. The oils were not toxic to the eggs, but killed a very high proportion of the larvae that hatched ; in some instances, all larvae in the second and later instars died. In general, the heavier the oil and the higher the concentration, the lower the survival of larvae. Toxicity was not increased by the addition of cubé.

In another test, uninfested lemon foliage was sprayed with emulsions of the three oils at 1·67 per cent. or of the light-medium oil with cubé and exposed to infestation 0–3, 3–6 and 6–9 days after treatment. There was evidently sufficient oil on the leaves for the three days after spraying to repel some of the ovipositing females. There was no difference in percentage hatch between eggs laid on treated and untreated foliage. Fewer first-instar larvae survived on foliage exposed to infestation for the first three days after spraying than on that exposed on the next three days, and the effect of the oil decreased sharply in the third group. Many larvae surviving the first instar died in the second, and high populations occurred only on untreated plots. Populations of third-instar larvae and pupae were more reduced on foliage that had been sprayed with light-medium oil, with or without cubé, than on that treated with light oil. No living third-instar larvae or pupae were found on leaves that had been treated with medium oil.

Wilcox (J.) & Howland (A. F.). **New Insecticides for Control of Onion Thrips in Southern California.**—*J. econ. Ent.* **43** no. 5 pp. 690–693, 11 refs. Menasha, Wis., 1950.

In experiments against *Thrips tabaci* Lind. on onion in southern California in 1948 and 1949, dusts containing various organic insecticides were applied at approximately 30 lb. per acre per application. In 1948, dusts containing 1 per cent. parathion or lindane [at least 99 per cent. γ BHC (benzene hexachloride)], enough BHC to give 1 per cent. γ isomer, 5 per cent. DDT, DDD (TDE [dichlorodiphenyldichloroethane]), methoxy-DDT (methoxychlor) or chlordan or 10 per cent. toxaphene, and the same insecticides at twice the concentration, were applied on 17th February and 4th March in one field and the stronger dusts on 25th March and 7th April in another. Thrips populations were not large, and control with two applications of the effective materials was considered satisfactory, as the onions were harvested during May. The weaker dusts gave 35–68 per cent. control of nymphs and 0–48 per cent. of adults, and the stronger ones 48–86 and 35–71 per cent., respectively, in the first field and 52–90 and 33–56 per cent. in the second. Chlordan, DDT, BHC, lindane and toxaphene gave significantly and parathion not significantly better control of the nymphs than DDD, and methoxy-DDT was inferior to all other materials. Chlordan, lindane, BHC, parathion, DDT and toxaphene were significantly superior to methoxy-DDT and DDD against the adults. There were no significant differences in yield, owing to soil variation in the field, but there was a tendency towards lower yields in DDT plots than in those receiving chlordan, BHC, lindane or toxaphene, and all treated fields yielded more than untreated ones. DDT seemed to affect the growth in such a manner as to delay the curing of the plants after irrigation was stopped, which is undesirable as early onions must be cured and marketed rapidly.

In 1949, applications were made on 24th May and 1st and 9th June in one field and on 31st May and 8th and 16th June in another. Thrips populations were extremely high in the first field and moderate in the other. The insecticides used were 20 per cent. toxaphene, 2 per cent. parathion, 2·5 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], 10 cent. chlordan, DDT, DDD or fluoro-DDT (difluorodiphenyltrichloroethane) and 1 per cent. aldrin. When the counts for the two fields were averaged, significant reductions in nymphs were given only by the first four and in adults by the first three. Yields were recorded in the first field, and though there were no significant increases, the better treatments gave the higher yields.

Hamilton (D. W.). *Profenusa canadensis*, **a Pest of English Morello Cherries in eastern New York.**—*J. econ. Ent.* **43** no. 5 pp. 694–696, 3 refs. Menasha, Wis., 1950.

Infestation of English morello cherries by *Profenusa canadensis* (Marl.) in eastern New York [*cf. R.A.E.*, A **31** 307] had become general in nearly all plantings in four counties by 1949, and in many 30–50 per cent. of the leaves were so severely mined by early June that they could no longer function or had dropped. Recent observations indicate that the sawfly is gradually extending its range of food-plants from hawthorn [*Crataegus*] and English morello cherry to other varieties of cherry. It was found on the Montmorency variety, the most common sour cherry in New York, in 1946, and on a few leaves of the Windsor variety of sweet cherry in 1949. It has one generation a year [*loc. cit.*] and a very short season of activity. In 1938–49, adult emergence began between 27th April and 12th May, reached a peak between 29th April and 20th May and was completed between 4th and 19th May. All adults died by 31st May.

As many as 635 emerged from the soil under a single tree in an area of 64 sq. ft. Oviposition began soon after emergence, and the first eggs were observed between 6th and 18th May and the first larvae between 11th and 27th May. The larvae matured rapidly within the leaves and left their mines between 29th May and 3rd June to enter the soil.

A spray of aliphatic thiocyanate, cubé and summer oil in water [*cf. loc. cit.*] was superior to others in tests in 1943–47 but killed only 44–89 per cent. of the larvae. In 1945 and 1946, emulsified solutions of DDT alone were ineffective, but a spray of 1 quart 25 per cent. DDT emulsion concentrate and 1 gal. summer oil per 100 gals. water killed 50–75 per cent. of the larvae. In field experiments in 1949, BHC (benzene hexachloride) and chlordan were tested against half-grown larvae. Sprays of 3 lb. wettable powder containing 6 per cent. γ BHC, 1·5 or 2 U.S. pints BHC emulsion concentrate (11 per cent. γ isomer), 10 oz. emulsion concentrate containing 25 per cent. lindane [at least 99 per cent. γ BHC] or 6 lb. 50 per cent. chlordan wettable powder per 100 U.S. gals. gave complete mortality, and 1 pint BHC emulsion concentrate or 1–1·5 pints 74 per cent. chlordan emulsion concentrate per 100 gals. gave almost complete mortality.

In an attempt to kill the adults before they oviposited, two applications were made of a 50 per cent. DDT wettable powder at 2 lb. per 100 U.S. gals. in 1946–48 and at 3 lb. in 1949 and of the BHC wettable powder at 4 lb. per 100 U.S. gals. in 1949. The applications were made when the trees were in full bloom (shortly after adults began to emerge) and 7–8 days later (at petal-fall) in 1946 and 1947 and at the late pink stage and when three-quarters of the petals were off in 1948 and 1949. DDT gave 80, 82, 64 and 9 per cent. reduction of injured leaves in the four years, respectively, and BHC 88 per cent. However, it is illegal to apply poisonous sprays at full bloom in New York, and the set of cherries was reduced by 49 per cent. in 1947. BHC is considered promising.

Rockwood (L. P.). **Entomogenous Fungi of the Family Entomophthoraceae in the Pacific Northwest.**—*J. econ. Ent.* **43** no. 5 pp. 704–707, 5 refs. Menasha, Wis., 1950.

The author has made observations on various species of Entomophthoraceae in Oregon over a number of years ; the members of this family are the most effective agents of fungous disease in insects, and under favourable conditions, control large and destructive outbreaks. Every year in the Willamette Valley, larvae of *Hypera punctata* (F.) are prevented from causing appreciable injury to the clovers and lucerne by *Empusa* (*Entomophthora*) *sphaerosperma*, whereas in the more arid areas east of the Cascade Mountains, they often damage them. Caterpillars, particularly Noctuid larvae, are frequently killed by *Empusa virescens* ; this fungus destroyed many larvae of *Dargida procincta* (Grote) in canary-grass [*Phalaris*] near Coquille, Oregon, in 1928. In 1926, larvae of *Chorizagrotis auxiliaris* (Grote) denuded several hundred acres of rye and wheat in Washington by November, when they were still in early instars, but by March 1927, only dead larvae containing spores of a fungus that might have been *E. virescens* were found in the grain fields, though healthy larvae were numerous in their natural habitat. Large numbers of *Melanoplus femur-rubrum* (Deg.) and *M. mexicanus* (Sauss.) containing resting spores agreeing with descriptions of *Empusa grylli* have occasionally been found dead on the tops of lucerne plants in irrigated fields east of the Cascade Mountains. *E. muscae* often kills Syrphids and other Diptera in the fields of western Oregon, and another species, probably *E. forficulae*, is frequently found there on *Forficula auricularia* L., and is believed to be an important factor in the natural control of the earwig.

The fungi that infest Aphids in Oregon are *E. aphidis*, *E. thaxteriana* and *E. fresenii*. *E. fresenii* was occasionally found in the Willamette Valley in July, notably on *Macrosiphum onobrychis* (Boy.) (*pisi* (Kalt.) ) on Scotch broom [*Cytisus scoparius*] and *M. avenae* (F.) (*granarium* (Kby.) ), *Rhopalosiphum prunifoliae* (Fitch) and *Myzus persicae* (Sulz.) on oats. *E. aphidis* often destroys enormous populations of *Macrosiphum onobrychis* on common vetch and Austrian winter field peas in the Willamette Valley, enabling the plants to recover from severe Aphid injury. Colonies of *M. onobrychis* showing a combined attack by *E. aphidis* and *E. thaxteriana* were found there as early as February, but *E. aphidis* predominated, and only a few spores of *E. thaxteriana* were produced. The importance of *E. thaxteriana* may be underestimated when both species are present, but *E. aphidis* is probably the most effective fungus attacking the Aphid in the Willamette Valley. The two species occurred in almost equal abundance in the Palouse area of Washington and Oregon, where the average annual precipitation is about 25 ins., and *E. thaxteriana* appeared to predominate in more arid regions with an annual precipitation of about 10 ins., probably because Aphids infected by it fall to the ground, where conditions are most humid in irrigated fields, whereas those infected by *E. aphidis* become attached to the leaves by rhizoids, usually near the tops of the plants. Moreover, resting spores are known to occur in *E. thaxteriana*, but have not been identified certainly in *E. aphidis*.

Aphids killed by *E. aphidis* first became abundant in fields of vetch or winter peas that had become infested in autumn. The fungus became established at about the same time as the Aphids, persisted through the winter and gave control by about April. In fields that had been sown late enough to escape Aphid infestation in the autumn, both the Aphid and the fungus became abundant a month or more later. In cages, the fungus did not develop when the original Aphids were free of it, and its dispersion appears to be largely by infected alate Aphids, which are impelled to migrate at an early stage of infection. Apterous Aphids also became restless in the early stages of infection and moved to the top leaves of the food-plants in the late afternoon. They died in the early evening, and if the relative humidity reached 90 per cent. or more in the night, the spore-bearing hyphae emerged from them and spores were discharged. If the Aphids were collected shortly before or after death and put in dry vials at humidities below 60 per cent., the hyphae did not emerge, and such mummified Aphids could be kept indefinitely and did not shrivel on drying out. Under dry conditions, the fungus survived in all of a batch of such Aphids for three weeks and in 42 per cent. for four weeks. These results indicate how the fungus persists in the field during dry periods and why its spread ceases when the night humidities do not reach 90 per cent. It can be differentiated from *E. thaxteriana* in the Aphid before spore production by characters of the hyphae, which are described.

The author records a method of obtaining pure cultures of *E. aphidis* from *Macrosiphum onobrychis* and various media of animal and vegetable origin on which it developed. Cultures remained viable for three months at about 50°F. in winter and four months in a refrigerator at about 36°F. during the summer. In 1936, when sporulating cultures were inverted over vetch plants infested with *M. onobrychis*, a strain in culture since 1934 killed up to 36 per cent. of the Aphids, while one begun in 1936 and fungus from an infected Aphid each killed about 95 per cent. This confirmed earlier indications that culture on artificial media caused the fungus to lose its virulence for Aphids. Since the fungi on Aphids die soon after spore production, which is usually over in one or two nights, the practice of collecting Aphids killed by them would probably be useless as a means of disseminating a species that does not produce resting spores, unless the dying and recently dead insects were air-dried before the hyphae emerged, and it is concluded that the chances of artificially inducing

epizootics among insects are much less with the Entomophthoraceae than with the hyphomycetous fungi, such as *Metarrhizium* or *Beauveria*.

SMITH (F. F.) & CLIFFORD (P. A.). **Translocation of Parathion from Foliage Applications.**—*J. econ. Ent.* **43** no. 5 pp. 708–712, 3 refs. Menasha, Wis., 1950.

The following is substantially the authors' summary. In greenhouse tests, parathion was applied to the foliage of 12 vegetables at a concentration of 2 lb. 25 per cent. wettable powder per 100 U.S. gals., the edible portions of the plants being protected from the spray by enclosure in parchment bags or celluloid cylinders. Colorimetric analyses of the protected portions showed no parathion in shelled lima beans or tomato ; less than 0·01 part per million in cucumbers, peppers [*Capsicum*] and radishes ; 0·04 and 0·01 p.p.m. in snap beans and beets, respectively ; and 0·13–0·34 p.p.m. in cabbage, Chinese cabbage, Swiss chard, collards and kale. Of the untreated plants used as controls, cabbage, collards and kale appeared to contain up to 0·15 p.p.m. parathion. Unbagged shelled lima beans from treated plants contained 11·2 p.p.m.

In field tests, snap beans from plants sprayed while in blossom showed no parathion at harvest, and those sprayed when they were 1·5 inches long showed 0·02 p.p.m. at harvest eight days later. Bagged cucumbers and summer squashes showed 0·02 p.p.m. parathion after two applications. At harvest, 14 days after treatment, shelled peas showed no parathion, whereas the plants showed 0·05 p.p.m. Strawberries from plants treated during blossoming or when the fruit was small contained 0·02 p.p.m., and application eight days before harvest resulted in 0·23 p.p.m. in the berries and 3·05 p.p.m. in the stems and caps.

In a greenhouse test in which parathion was applied as an aerosol at 1 gm. per 1,000 cu. ft., rose leaves showed a maximum of 33 p.p.m. four days later, but in nine days almost all of this had dissipated. The fumigating action of the residues on rose leaves against *Tetranychus bimaculatus* Harvey decreased with the dissipation of the parathion.

It is concluded from these results that parathion may be translocated from treated foliage in some vegetables, but only in minute quantities. Absorption of vapours was not precluded.

FISHER (F. E.) & GRIFFITHS jr. (J. T.). **The Fungicidal Effect of Sulfur on entomogenous Fungi attacking Purple Scale.**—*J. econ. Ent.* **43** no. 5 pp. 712–718, 7 graphs, 12 refs. Menasha, Wis., 1950.

The following is substantially the authors' summary. It was found in further experiments on orange in Florida in 1948–49 [*cf. R.A.E.*, A **38** 333 ; **39** 11] that wettable sulphur, lime-sulphur and a sulphur paste exerted toxic effects on the entomogenous fungi, *Myiophagus* sp. and *Hirsutella besseyi*. *Myiophagus* is a major factor in the natural control of *Lepidosaphes beckii* (Newm.), and *H. besseyi* is regularly found associated with mortality of the nymphs of this Coccid [*cf.* **39** 12]. Wettable sulphur had comparatively little fungicidal action, whereas sulphur paste was extremely toxic. Lime-sulphur was intermediate in action, and hydrated lime apparently had little or no fungicidal effect.

In general, infestation by *L. beckii* was most severe on trees sprayed with sulphur paste and progressively less so on trees treated with lime-sulphur, wettable sulphur, and lime, but trees receiving no treatment were much less infested than any treated ones. From the standpoint of obtaining the greatest possible amount of natural control of *L. beckii* by entomogenous fungi, therefore, it would be better to use wettable sulphur against *Phyllocoptruta oleivorus* (Ashm.) than lime-sulphur or sulphur paste.

FLANDERS (S. E.). **Races of apomictic parasitic Hymenoptera introduced into California.**—*J. econ. Ent.* **43** no. 5 pp. 719–720, 1 fig., 17 refs. Menasha, Wis., 1950.

It is shown from a brief review of the literature that although the eggs of completely apomictic species of parasitic Hymenoptera are not fertilised, these species may be bisexual as well as unisexual, and that geographical races based on such sexuality are known. It is also known that races differentiated by their hosts occur in an amphimictic species, *Comperiella bifasciata* How., of which only the Chinese race is adapted to the red scale, *Aonidiella aurantii* (Mask.) [*cf. R.A.E.*, A **31** 271, 328 ; **33** 374], and it has now been found that similar races occur also in two apomictic species, *Aspidiotiphagus citrinus* (Craw) and *Prospaltella perniciosi* Tower.

*A. citrinus* has been present in California for many years as a parasite of the yellow scale [*Aonidiella citrina* (Coq.)] and other Diaspine Coccids but not the red scale, and a race of *P. perniciosi* parasitic on *Quadraspidiotus* (*Aspidiotus*) *perniciosus* (Comst.) but not the red scale was introduced into California from Georgia in 1943 [**32** 371] and is now widely established. In 1948 and 1949, host-differentiated races of these species, both parasitic on the red scale, were introduced into California from China. The introduced race of *Aspidiotiphagus citrinus* was reared in large numbers on the red scale in the insectary and appeared to be morphologically indistinguishable from the race parasitic on the yellow scale, though the latter does not reproduce on the red scale in California either under natural conditions or in the insectary. *A. citrinus* was found as a parasite of the red scale in China and South Africa as long ago as 1900 and 1902, respectively, and a form of *Aspidiotiphagus* parasitising this host in Australia and sometimes recorded as *A. australiensis* Gir. [*cf.* **35** 6] is probably this species, since Noble, who reared it repeatedly, could not differentiate it from *A. citrinus* and the original description of *A. australiensis*, which was based on a Queensland specimen from an unknown host, does not provide characters for its separation. The author considers it undesirable to apply a differentiating scientific name to the form of *A. citrinus* parasitic on the red scale, since it represents an entity of unknown systematic position.

The red-scale race of *P. perniciosi* was introduced into California from Formosa, propagated in the laboratory and released in large numbers, and it now appears to be thoroughly established. This form and that parasitic on *Q. perniciosus* are both considered to have originated in Asia, probably in China. A record of *P. aurantii* (How.) parasitising *Q. perniciosus* in Japan [**9** 453] probably refers to *P. perniciosi* ; *P. aurantii* occurs in California but does not attack *Q. perniciosus* there.

PENCE (R. J.). **An Anobiid Beetle infesting Avocado Trees.**—*J. econ. Ent.* **43** no. 5 p. 724, 2 figs., 1 ref. Menasha, Wis., 1950.

Dead flower stalks and dried twig terminals of avocado in southern California were found to be infested by *Ozognathus cornutus* (Lec.), an Anobiid that is known to attack oak, on which it usually infests the twigs and supposedly exists also in the Cynipid galls on them, and has been found in the egg stage under the " button " of lemon fruits. Although it occurs in considerable numbers in avocado plantings, it is considered to be of little or no economic importance. The eggs are deposited in flat masses deep within cracks or under the dead terminal growth, and the larvae feed first in the surrounding dead tissue and later in living tissue if necessary to complete their development. They usually occur singly. They pupate within the cavities, and the adults gnaw circular exit holes.

Hamstead (E. O.) & Gould (E.). **Codling Moth Oöcyte Studies.**—*J. econ. Ent.* **43** no. 5 pp. 724–726. Menasha, Wis., 1950.

Bait-trap studies in West Virginia and elsewhere showed that trapping large numbers of adults of *Cydia* (*Carpocapsa*) *pomonella* (L.) in an apple orchard did not reduce infestation in the fruit, and a study of oöcyte production and maturation in trapped moths and moths reared from larvae taken from bands on the trees was undertaken in 1942 in an attempt to discover the reason for this. The information obtained may be useful in interpreting bait-trap catches for timing spray applications. The average mean day and night temperatures rose from 70 to 63°F. in May to 79 and 71°F. in July and were 75 and 68° in August, and the average life-span of reared moths decreased from about ten days in May and nine in June to 3–4 days in July and August.

Comparison of oöcyte counts in moths trapped during May–August 1942 with similar counts in reared moths of various ages showed that the total number was markedly less in trapped females than in reared ones, regardless of the age of the latter or the month. Among trapped moths, the total number of oöcytes per female was somewhat higher in May than in the warmer months, and among reared ones, those that were three days old had more than any others, regardless of the month, but had fewer early in the season than later. The average number of mature oöcytes was eight in trapped moths throughout the season, as compared with 51 and 60 in reared moths nine days old in May and June, respectively, and 83 and 85 in those three days old in July and August.

These results indicate that oöcyte formation and differentiation proceed faster in warm than in cool weather and that oöcyte formation reaches a peak early in the life of the moths, that moths lay a considerable proportion of their eggs before being caught in bait-traps, and that the number laid before the moths are caught is rather lower in the cooler early part of the season than later. The small number of mature oöcytes in captured moths indicates that the females oviposit much more readily in nature than in confinement ; oviposition was observed to be light in the cages and did not occur during the first three days of adult life. There were considerably fewer oöcytes in caged moths six days old than in those that were only three days old, possibly owing to reabsorption. The ratio of females to males was lower in captured moths than in reared ones.

Ditman (L. P.). **Fall Armyworm Control.**—*J. econ. Ent.* **43** no. 5 pp. 726–727. Menasha, Wis., 1950.

During the summer of 1949, an early outbreak of *Laphygma frugiperda* (S. & A.) occurred in parts of Maryland. Sweet maize found to be seriously infested at the Experiment Station on 1st August was treated on 2nd August, when the plants were 12–15 ins. tall. Sprays were applied with equipment designed for the control of the corn borer [*Pyrausta nubilalis* (Hb.)], the boom having three nozzles per row, and aerosols with a covered two-row dispenser. The spray pressure was 400 lb. per sq. in. when the rate of application was 200 U.S. gals. per acre and 100 lb. when the rates were less. The larvae per 100 plants were counted on 4th August and the amount of damage between 2nd and 8th August was estimated. The percentages by which the numbers of larvae and (in brackets) damage were less than on untreated plants were 100 (83·2) and 100 (91·2) for sprays containing 2 lb. 50 per cent. DDT wettable powder and 1 lb. 25 per cent. parathion wettable powder, respectively, per 100 U.S. gals., applied at 200 U.S. gals. per acre ; 97·7 (94·7) and 96·9 (91·5) for sprays of 1 quart 30 per cent. DDT emulsion concentrate per 100 gals. at 200 and 80 U.S. gals. per acre ; 71·2 (77·6) and 82·6 (81·4) for sprays of 1 quart 30 per cent. DDT concentrate in 10 and 30 gals. water, applied at 7·5 and 15 U.S. gals. per acre, respectively ; and 68·6 (63·2) and 65·5 (64) for aerosols

containing 5 and 10 per cent. DDT applied at 15 lb. per acre. Nearly full-grown larvae feeding deep in the heart of the curl and protected by a layer of grass were the most difficult to kill. It was evident later in the season that effective early control of *L. frugiperda* resulted in greatly increased yields.

TOMLINSON jr. (W. E.). **Summer Oil Sprays to control Blueberry Bud Mite.**—*J. econ. Ent.* **43** no. 5 p. 727. Menasha, Wis., 1950.

In New Jersey in 1947, injury to the flower buds of blueberry by *Aceria* (*Eriophyes*) *vaccinii* (Keifer) was not alleviated by sprays applied during the delayed-dormant and pre-bloom periods, although a fair kill of the mites was obtained with some materials. Examination of buds during the summer, autumn and winter of that year indicated that mites were present under the leaf- or fruit-bud scales in all stages throughout the year [*cf. R.A.E.*, A **29** 259]. Injury to the fruit buds began in late summer, soon after the buds were formed, and continued throughout the autumn and winter on warm days, though the mites were usually still feeding only under the outer bud scales during late summer and early autumn.

In 1948, infested bushes were sprayed with 2 per cent. summer oil directly after harvest in August and before the mites had penetrated the buds to the flower parts. The immediate results appeared promising, but infestation decreased naturally throughout the area in autumn and winter, and no differences could be observed between sprayed and unsprayed bushes in spring.

Bushes sprayed with 3 per cent. summer oil once or twice in early October 1949 at an interval of ten days showed excellent mite control a week later, and when groups of 150 plants were examined during the blooming period in May 1950, the numbers of blossom clusters with gross feeding injury were 18 and 1, respectively, as compared with 505 for no treatment.

YOUNG (M. T.) & GAINES (R. C.). **Tests of Insecticides to control Boll Weevil, Cotton Aphid, and Two-spotted Mite.**—*J. econ. Ent.* **43** no. 5 pp. 727–729. Menasha, Wis., 1950.

The results are given of four tests at Tallullah, Louisiana, in 1949 in which dusts of calcium arsenate, organic insecticides or both were applied to cotton with a single-nozzle rotary hand duster during the early mornings, for the control of *Anthonomus grandis* Boh., *Aphis gossypii* Glov. and *Tetranychus bimaculatus* Harvey. In all four tests, calcium arsenate alone gave significant control of the weevil and caused a marked increase in infestation by the Aphid, and all dusts containing synthetic insecticides, except the 5 per cent. chlordan in the first test, also gave significant weevil control. In the first test, 5, 10 and 15 per cent. chlordan with 40 per cent. sulphur and 10 per cent. chlordan with both sulphur and 5 per cent. DDT were the least effective treatments. Calcium arsenate with 2 per cent. nicotine in alternate applications, a mixture of 5 per cent. DDT, enough BHC (benzene hexachloride) to give 3 per cent. γ isomer and 40 per cent. sulphur, used alone or alternated with various applications of calcium arsenate, and 20 per cent. toxaphene with 40 per cent. sulphur all gave good control of the three pests and substantial gains in yield.

In the second, a mixture of 3 per cent. γ BHC and 40 per cent. sulphur gave good control of the three species, but a very small gain in yield, which was much improved by the inclusion of 5 per cent. DDT. Calcium arsenate with 2 per cent. nicotine in alternate applications and calcium arsenate supplemented by the mixture of DDT, BHC and sulphur as needed against *A. gossypii* also gave good control and satisfactory gains in yield. Toxaphene was equally effective and gave similar results when applied at 40 per cent. in clay at 8 lb. per acre and at 20 per cent. in pyrophyllite at 12 lb. per acre, and applications of about 1 lb. chlordan per acre as a 20 per cent. clay mixture or a 10 per cent.

pyrophyllite mixture were less effective than most of the other insecticides tested.

In the third test, 2 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] gave good control of the two insects and a greater gain in yield than any other material tested, while 1·5 per cent. dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a- octahydro-1,4,5,8-diendomethanonaphthalene] was rather less effective; both caused increases in the mite population. Dusts containing 10 per cent. chlordan, or 20 per cent. toxaphene, or 3 per cent. γ BHC with 5 per cent. DDT gave good control of the Aphid and gains in yield, but were slightly less effective against the weevil and permitted increases in the numbers of mites, which were not always reduced by the inclusion of 40 per cent. sulphur.

In the last, regular calcium arsenate and two brands of calcium arsenate with a very low lime content gave similar results when used alone, though the regular material permitted a slightly greater increase in the Aphid population. When 1 per cent. γ BHC was added, it was much more effective in preventing the increase of Aphids in the special calcium arsenate than the regular one [*cf. R.A.E.*, A **39** 172]. The special calcium arsenates with 1 per cent. parathion gave good control of all species and substantial gains in yield, but a special BHC in the usual mixture with DDT and sulphur did not improve control. Mixtures containing 5 per cent. γ BHC with 5 or 10 per cent. DDT and 30·7 or 21 per cent. sulphur, respectively, were very effective against the two insects and gave very substantial increases in yield; results against the mite were not estimated.

STAFFORD (E. M.) & BARNES (D. F.). **Sprays for Fig Scale Control.**—*J. econ. Ent.* **43** no. 5 pp. 730–731, 1 ref. Menasha, Wis., 1950.

Control measures suggested against *Lepidosaphes ficus* (Sign.) on fig in California as a result of earlier investigations [*cf. R.A.E.*, A **38** 110] were considered inadequate by some growers in 1948, and further tests of the proposed dormant oil sprays were therefore carried out in 1949. All sprays were applied from the ground by men walking round the trees unless otherwise stated, and spray quantities are given per 100 U.S. gals. water. The degree of control obtained was estimated in various ways, but chiefly as the percentage of figs with four or more scales (referred to below as fig infestation), and on this criterion, all treatments were significantly better than none.

In a test on Kadota figs, 4 U.S. gals. tank-mix dormant emulsive oil (about 98 per cent. actual oil) with 4 oz. blood-albumin spreader, 4 U.S. gals. dormant emulsive oil or 5 U.S. gals. dormant oil emulsion (about 80 per cent. actual oil), applied in February, and 10 oz. 25 per cent. parathion applied in May, reduced fig infestation from 13·9 to 0·1–0·6 and were significantly more effective than 1 lb. 25 per cent. parathion applied in June, which reduced it to 2·9. On Adriatic figs with an initial infestation of 3·6 scales per inch of twig, 15 oz. 25 per cent. parathion applied in June, reduced fig infestation from 15·1 to 0·03 and was significantly better than all other treatments, while 3·5 U.S. gals. dormant emulsive oil and 4·5 U.S. gals. dormant oil emulsion, applied in February, reduced it to 0·7 and 0·3 and were significantly better than the former applied by spray men riding the rig but little better than 1 lb. 25 per cent. parathion, applied in July. On Adriatic figs with an initial infestation of 5·6 scales per inch of twig, 5 U.S. gals. dormant oil emulsion with 10 oz. 25 per cent. parathion applied in February reduced fig infestation from 49·6–55·6 to 1·5 and was significantly better than all other treatments. The fig infestations were 6·8 and 5·4 for 10 oz. and 1 lb. 25 per cent. parathion, applied alone in May and July, respectively, 11·6 and 14·2 for 5 U.S. gals. dormant oil emulsion and 3 U.S. gals. dormant emulsive oil, applied in February and March, respectively, and 10·5

for 3 U.S. gals. tank-mix dormant oil with 4 oz. blood-albumin spreader, also applied in March.

Parathion wettable powders have not been recommended for use with petroleum oil emulsions, and such combinations are considered too hazardous to apply. After 41 days (7th July to 17th August), no parathion residue was found on figs sprayed with 1 lb. 25 per cent. parathion.

CHAMBERLIN (T. R.) & MEDLER (J. T.). **A Comparison of Methods for estimating Populations of Spittlebug Nymphs in Alfalfa.**—*J. econ. Ent.* **43** no. 5 pp. 731–732. Menasha, Wis., 1950.

In 1949, counts of infested and uninfested lucerne stems in samples selected at random in three fields in Wisconsin showed the percentage control of nymphs of *Philaenus leucophthalmus* (L.) given by toxaphene to be 79·3–94·9, whereas counts of the stems and the nymphs on them indicated 95·2–98·9 per cent. control. Counts of nymphs thus show the reduction in population more accurately, but they are too time-consuming to permit examination of adequate samples in ordinary field work. Since counting the stems gives a conservative estimate of efficiency, it is considered satisfactory.

MAYEUX (H. S.) & WENE (G. P.). **Control of Serpentine Leaf Miner on Pepper.**—*J. econ. Ent.* **43** no. 5 pp. 732–733, 1 ref. Menasha, Wis., 1950.

A leaf-miner of the group of *Liriomyza pusilla* (Mg.) has been a major pest of peppers [*Capsicum*] in the Lower Rio Grande Valley of Texas since 1940. Many other cultivated crops and many ornamental plants are infested, but not seriously. Heavy infestations on peppers cause defoliation, resulting in reduced yield. The insect is active throughout the year, and field observations in 1948 indicated that it becomes more numerous after the use of certain poisons, especially BHC (benzene hexachloride) and DDT.

In the autumn of 1949, a dust containing 5 per cent. chlordan, 5 per cent. DDT and a fungicide and one containing 1 per cent. γ BHC, 5 per cent. DDT and a fungicide were applied to bell-peppers at 20 lb. per acre with rotary hand dusters, six times at intervals of seven days. The second dust is used extensively in the area for the control of the pepper weevil, *Anthonomus eugenii* Cano, and *Heliothis armigera* (Hb.). On 26th October, after the third application, the numbers of mined leaves per plant averaged 13 on the chlordan plots, 23 on the BHC plots and 49 on the untreated ones. The percentages of undamaged leaves and (in brackets) the average numbers of mines per leaf on these plots were 43 (1·2), 15 (3·5) and 6 (5·9) after the fourth application, 27 (2·7), 7 (7·1) and 0·4 (11·8) after the fifth and 6 (21), 0 (28) and 0 (26) three weeks after the sixth. The average numbers of pods per plant (and of fallen pods per 100 yards of row) after the sixth application were 8·6 (9·5), 6·6 (12·5) and 5·4 (15). A month after the last application (15th December), the leaves had become more heavily infested on treated than on untreated plants, and by the end of December the treated plants were almost completely defoliated. The destruction of natural enemies by the use of the insecticides and the presence of more tender foliage in treated plots, to which the adults were attracted, are possible explanations of this. Adult leaf-miners were observed at the rate of at least five per plant over the entire field on 15th December. Neither BHC nor chlordan killed many larvae, if any, inside the mines, and the control they gave is attributed to destruction of the adults before eggs are deposited.

It is concluded that the leaf-miner can be controlled by a dust containing 5 per cent. each of chlordan and DDT applied weekly at 20 lb. per acre, but that infestation is likely to become very heavy when dusting is discontinued or if applications are irregular.

Cotton (R. T.). **Notes on the Almond Moth.**—*J. econ. Ent.* **43** no. 5 p. 733. Menasha, Wis., 1950.

*Ephestia cautella* (Wlk.) was first recorded in the United States in 1884, but had probably been introduced much earlier. It has been found attacking nut meats and dried fruit, but its true importance as a pest of foodstuffs and its widespread occurrence in the United States have probably not been fully realised. Outbreaks occurred in the warehouses of bean dealers in Texas in 1948 and 1949, when black-eyed cow peas were particularly seriously damaged. These had been fumigated as a routine practice to control field infestation by *Bruchus* (*Callosobruchus*) *maculatus* F., but quickly became infested by *E. cautella* when stored in bags. It is troublesome chiefly during the summer months, though the moths were observed flying in bean warehouses in San Antonio in January 1950. It was also found in all seed stores in Oklahoma and Texas, being particularly troublesome as a pest of seed maize, and was common in grain stores on farms in the Gulf States, where it was found infesting both rough rice and grain sorghums.

*E. elutella* (Hb.), which is reported to be a serious pest of wheat in bulk storage in England [*R.A.E.*, A **36** 210], has not been observed as a pest of stored wheat in the United States, but in the autumn of 1949, a heavy surface infestation by *E. cautella* was found in wheat stored in a ship's hold on the Hudson River. *E. cautella* is potentially a serious pest of many types of stored food products, and is more likely to be destructive in the southern States and those on the Atlantic and Pacific seaboards, where the climate is mild, than in colder parts. Although some field infestation may occur in warm climates, it is essentially a warehouse pest and subject to control by sanitation, good warehouse management and fumigation. In warehouses that are not adapted for fumigation, pyrethrum sprays are useful.

Blanchard (R. A.) & Gouck (H. K.). **DDT-Oil Emulsion for combined Control of Corn Earworm and European Corn Borer.**—*J. econ. Ent.* **43** no. 5 pp. 734–735, 1 ref. Menasha, Wis., 1950.

Two experiments on the control of *Heliothis armigera* (Hb.) in ears of sweet maize with emulsions containing DDT and mineral oil were carried out in Illinois in August 1949. Larvae of *Pyrausta nubilalis* (Hb.) in the ears were also counted. All the emulsions were prepared from a proprietary 25 per cent. DDT emulsifiable concentrate with xylene as the solvent and an unknown emulsifier, and the mineral oil had a viscosity of 80–90 secs. Saybolt. In each test, about 2 ml. emulsion was sprayed on each ear. The variety of maize used (Country Gentleman) was much more susceptible to damage by the emulsion than any other hybrid treated in previous tests. The spray caused shrinkage and separation of the husks and exposure of the kernels to weathering ; this exposure also gave the larvae free access to the kernels.

In the first test, the sprays were applied three times, on 10th, 13th and 15th August, when 25, 76 and 96 per cent. of the ears were in silk ; twice, on 10th and 13th August ; or once, on 13th August. Against both species, three applications of 1 per cent. DDT without oil or with 5 or 10 per cent. oil or of 0·5 per cent. DDT with 5 per cent. oil gave better results than two of the same materials. One or two applications of 1 per cent. DDT with 25 per cent. oil or one with 50, 67 or 75 per cent. oil gave about the same results as three applications of 0·5 per cent. with 5 per cent. oil or 1 per cent. with 5 or 10 per cent. oil. The largest percentage of uninfested ears (over 90) and the greatest percentage reductions in numbers of larvae per ear (over 90 in both species) were obtained in plots treated three times with 1 per cent. DDT and 10 per cent. mineral oil or once with 1 per cent. DDT and 50 or 67 per cent. oil. Unfilled and damaged ears on plots sprayed with DDT and 25–75 per cent. oil

were possibly due, at least partly, to the high susceptibility of the hybrid to spray damage.

In the second test, seven different combinations were applied two or three times. The first and second applications were made on 18th and 21st August, when 30 and 50 per cent. of the ears were in silk, and the third on 24th August. The sprays caused greater husk separation and ear damage in this test. All caused a greater increase in uninfested ears and reduction in the numbers of larvae of both species per ear when applied three times instead of two. Three applications of 0·5 and 1 per cent. DDT with 10 per cent. oil gave the highest percentages of uninfested ears (67 and 75), three of 0·5 per cent. DDT with 10 per cent. oil or of 1 per cent. DDT with 5 or 10 per cent. oil caused the greatest percentage reductions in numbers of *H. armigera* (77–80), and three of 0·5 or 1 per cent. DDT with 5 per cent. oil or 1 per cent. with 10 per cent. oil caused the greatest percentage reductions in *P. nubilalis* (81–86). Emulsions containing 0·25 per cent. DDT with 5 or 10 per cent. oil or 1 per cent. DDT with no oil were the least effective. Control was poor throughout this test, owing to lack of proper timing of applications.

Hagen (K. S.) & Finney (G. L.). **A Food Supplement for effectively increasing the Fecundity of certain Tephritid Species.**—*J. econ. Ent.* **43** no. 5 p. 735, 1 ref. Menasha, Wis., 1950.

Following similar work with a Chrysopid [*R.A.E.*, A **38** 434], the authors report that enzymatic yeast hydrolysates are being used successfully in the mass-culture of *Dacus ferrugineus dorsalis* Hendel, *D. cucurbitae* Coq. and *Ceratitis capitata* (Wied.), their inclusion in the diet of the flies shortening the preoviposition period and increasing fecundity throughout life as compared with diets containing powdered brewer's yeast. A diet of yeast hydrolysate is not adequate without the addition of honey or sucrose as a source of carbohydrate ; an effective combination was found to consist of 20–50 per cent. yeast hydrolysate solution smeared on wax paper, accompanied by another sheet of wax paper brushed with honey or an 80 per cent. sucrose solution, with water supplied separately. Solid yeast hydrolysate with solid sucrose is also an effective diet for both species of *Dacus*.

Apt (A. C.). **A Method of rearing the Flat Grain Beetle and the Grain Mite.**—*J. econ. Ent.* **43** no. 5 p. 735. Menasha, Wis., 1950.

The author describes a method developed in Minnesota for rearing *Laemophloeus minutus* (Ol.). To keep the culture medium at the high moisture content necessary, a cardboard carton 11·5 ins. high and 4·5 ins. in diameter was half-filled with flour and a glass vial 3·75 ins. long was inserted to half its length in the flour and kept filled with water. After adults of *L. minutus* had been added, the carton was covered and kept in a dark cabinet at about 80°F. A healthy culture was maintained for more than four months and appeared likely to continue indefinitely. *Tyroglyphus farinae* (Deg.) (*Acarus siro* auct.) was reared by the same method in a wide-mouthed screw-top glass jar instead of the cardboard container. A culture of the mite was still thriving after more than five months.

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The Institute will be greatly indebted to readers who may be able to supply any of the following, which should be sent to the Director, Commonwealth Institute of Entomology, 41, Queen's Gate, London, S.W.7.

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